INSECT MANUFACTURES

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INSECT
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If we are struck with wonder and admiration at the progress of the arts and manufactures, and have daily reason to congratulate ourselves on the skill and ingenuity of our fellow-creatures, by which our comforts and conveniences are so much increased; it must also occasionally have crossed our minds, that some of the meaner creatures, though not gifted with our reasoning powers, and therefore not able to profit by the experience of the past, are yet employed in their several departments, and according to their several wants, in exceedingly curious and useful manufactures, mostly designed for the shelter and preservation of themselves or their offspring, but serving, not

unfrequently, a higher purpose, in administering to the wants of mankind.

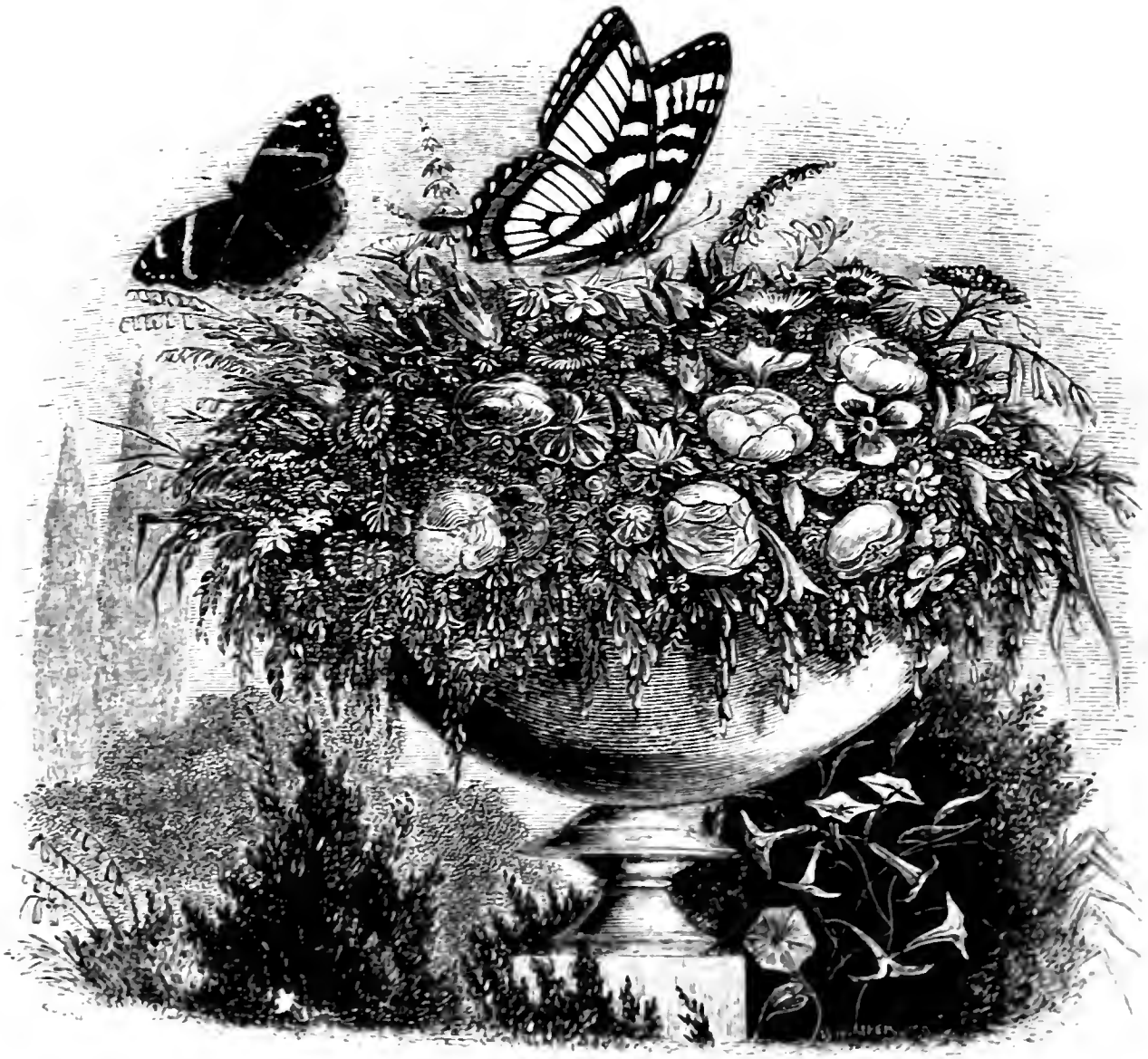
In reading the history, or in watching the proceedings of birds and insects, how many remarkable instances do we meet with of that which may be called *manufacture*, though performed without hands! How curious to watch in the early spring the proceedings of those busy basket-making birds, the rooks! Rude and clumsy as their nests may at first appear, it is just the sort of workmanship best calculated for their wants. They do not, indeed, choose the smooth and flexible osier-twigs which we should think necessary for basket-making, but they contrive by means of brittle, dead, forked sticks, to plait together a strong bristling out-work, within which they interweave a finer basket-work of fibrous roots, rude indeed, but not inelegant or unsuitable. Then, among birds and insects too, what persevering and industrious carpenters, masons, tailors, miners, and weavers may we not find. Perhaps there are not many persons who have watched the mason-wasps boring their galleries in brick or sand, or building the round towers which serve them as out-works;

nor the mason-bee, as she plasters together her neat mud-wall cottage or cell, as the future habitation of her young; but there are few persons unacquainted with the masonry of the chimney swallow, or of the house-martin twittering on the eaves. With no other tools than those which nature supplies, how cleverly do these creatures shape and mould their nests into the required form, using for their work a mortar carefully prepared by their own labour and skill, and just of the consistency required. Few, again, may have had an opportunity of seeing carpenter-bees boring holes in posts or palings, and forming their smoothly chiselled cells, or of inspecting the partitioned galleries dug out in old timber by carpenter-wasps; but perhaps many persons have observed the colonies of emmets, or carpenter-ants, working in the trunks of decaying oak or willow trees; or they may have listened to that interesting carpenter-bird, the wood-pecker, tapping and boring into trees, in pursuit of insects, and for the purpose of making a nesting-place for its young. Most of us know only by hearsay that there are tailor-birds, common enough in American orchards, who sew

together broad pieces of grass to make their nests, working them through and through, as if actually done with a needle; but almost every one can say from his own knowledge, that there are weaver-birds, such as our common hedge-sparrow and chaffinch, who weave a circular piece of haircloth for the interior of their nests, each hair being collected and interwoven singly, and always bent so as to lie smoothly in the hollow of the nest. Then who shall describe all the wondrous proceedings of tent-making caterpillers, upholsterer-bees, turret-building ants, net-making spiders, paper and card-making wasps, and spinning worms? Volumes have been written, and volumes might still be written on the history of these creatures. Any one possessing a garden, and taking delight therein, has ample opportunity of watching the habits of birds and insects, and of confirming, if not of adding to, the accounts given by naturalists, of the commoner species. But we must still be indebted to the patient observations of those who have made insects or birds their especial study, for many of the most curious particulars, and for all our knowledge of rare or foreign species.

Interesting as is the whole subject of bird and insect manufactures, there is one department in which we are more concerned than the rest; namely, that in which the product can be applied to our own use, either in the way of food or clothing. Now this department is supplied wholly by insects, no bird, that we are aware of, producing by its own manufacturing powers, any substance that can be so employed, unless, indeed, we except the curious edible nests of the Java swallow, which have been converted by the taste of oriental epicures into an article of food.

Let us then proceed to notice such of the insect manufactures as are useful to man, and trace, at the same time, the history and performances of these small but not insignificant manufacturers.



CHAPTER I.

MANUFACTURE OF SILK BY CATERPILLARS OF VARIOUS KINDS.

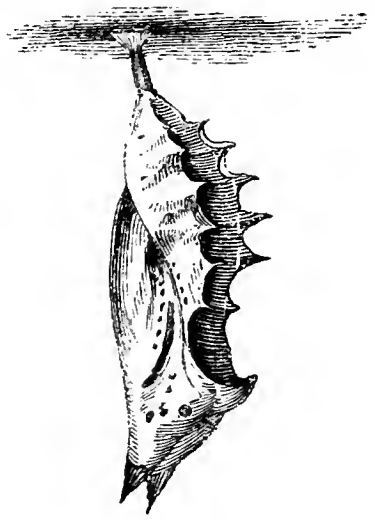
The most important of all the insect manufactures is doubtless that of silk-spinning. It seems almost past belief that the magnificent velvets, satins, and silks which form so elegant a part of female attire, and which are heaped together in such costly profusion in the shops of the metropolis, and in those of all considerable towns, whether in our own, or in foreign countries—that these splendid fabrics, together with all ribbons, gauzes, damasks, or other articles composed of silk, should owe the raw material of which they are formed to the labours of a race of little creeping caterpillars, which in this their early and imperfect state spin for themselves cocoons, or cases of silk,

where they may quietly undergo their changes until they become perfect winged insects.

The astonishing task of supplying silk for the whole civilized world is performed almost without exception by the common silkworm, or caterpillar of the mulberry-tree moth. But it must not be supposed that this is the only silk-producing insect. On the contrary, all the caterpillars of butterflies and moths have the power of spinning a certain quantity of silken thread, however small, and however inferior to that of the silkworm, properly so called. It is very common in gardens to see numbers of caterpillars dangling by their silken threads from the young branches of fruit-trees. In this way they let themselves down, or break their fall if blown off by the wind, or otherwise shaken from their favourite tree. And in the case of some caterpillars

CATERPILLAR SUSPENDED BY ITS SILKEN THREAD.

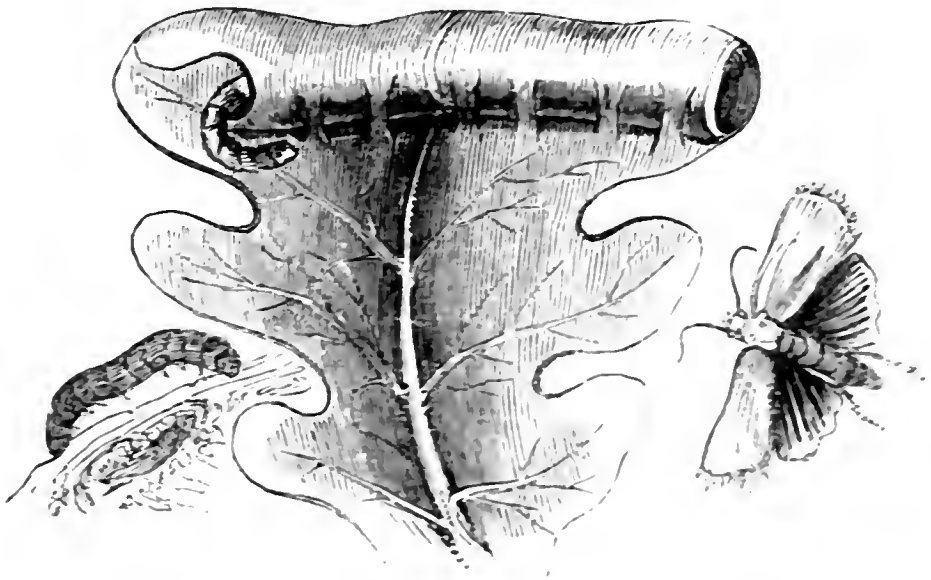
when the insect has completed the term of its existence and becomes a chrysalis, it suspends itself by silken cords to some fixed point, where it remains in complete repose, without food, perhaps for months before the perfect winged insect bursts forth, as different a creature from the caterpillar as the chrysalis is from either,—and yet these are but three different states of existence of the same insect.



CHRYSALIS SUSPENDED BY SILKEN CORDS.

According to the particular species of caterpillar, the silk will vary in strength and fineness, and also in colour, but seldom will it be found strong enough, or in sufficient quantity to be of use to us. The insects themselves employ it in many ways for their own safety and shelter. How common it is to find some of the leaves of a lilac-tree made up into little rolls, or folded together at their edges, where they stick so fast that it requires some little force to pull them asunder. This is the work of a small caterpillar, whose subsistence is found on

that tree. A single egg has been laid on each leaf selected by the parent moth, and soon after it is hatched, the caterpillar begins rolling up the lilac leaf, and fastening the edges with silk. This is a work of time, but gradually proceeds as the caterpillar increases in strength, until at last it is shut up in a gallery of its own making, safe from the attacks of birds and larger insects. The leaves of various other trees are rolled in a somewhat similar manner, as those of the oak, the



OAK LEAF ROLLED BY A CATERPILLAR.

willow, and the rose, and also those of humbler plants, as the plantain, nettle, thistle, &c. The

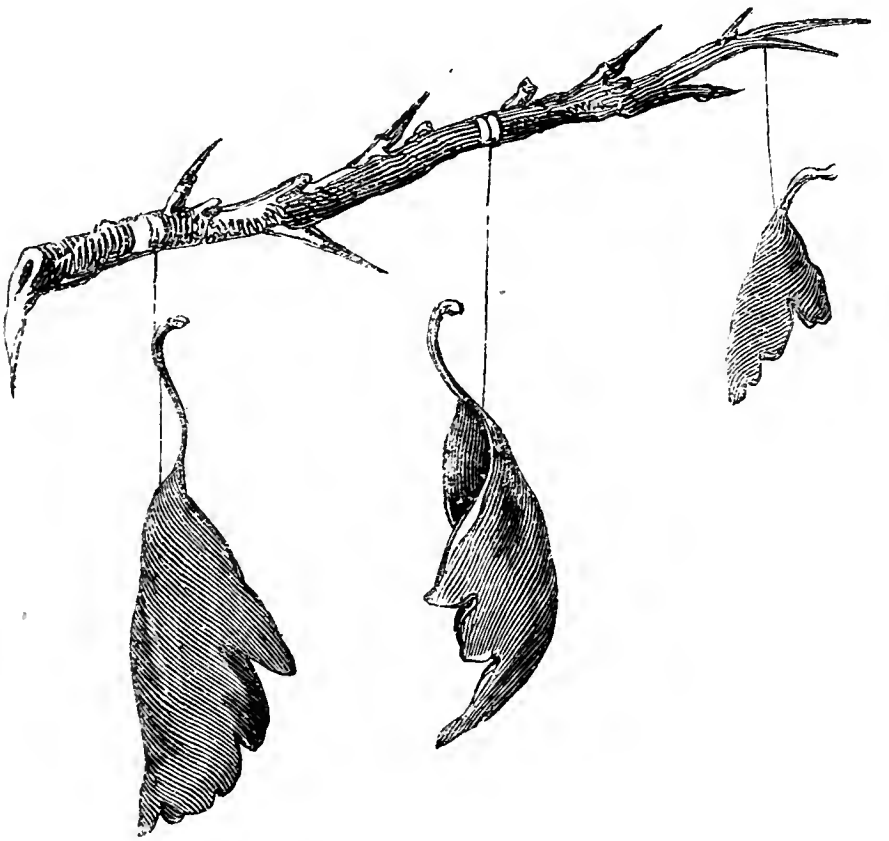
mode in which these leaf-rolling caterpillars set to work to form convenient habitations of the leaves of the plants on which they feed, is well described by Kirby and Spence.

"Some of these merely connect together with a few silken threads several leaves, so as to form an irregular packet, in the centre of which the little hermit lives. Others confine themselves to a single leaf, of which they simply fold one part over the other. A third description form and inhabit a sort of roll, by some species made cylindrical, by others conical, resembling the papers in which grocers put their sugar, and as accurately constructed; only there is an opening left at the smaller extremity for the egress of the insect in case of need. If you were to see one of these rolls, you would immediately ask by what mechanism it could possibly be made—how an insect, without fingers, could contrive to bend a leaf into a roll, and to keep it in that form until fastened with the silk which holds it together? The following is the operation: the little caterpillar first fixes a series of silken cables from one side of the

leaf to the other: she next pulls at these cables with her feet; and when she has forced the sides to approach, she fastens them together with stronger threads of silk. If the insect finds that one of the larger nerves of the leaf is so strong as to resist her efforts, she weakens it by gnawing it here and there half through. What engineer could act more sagaciously? To form one of the conical or horn-shaped rolls, which are not composed of a whole leaf, but of a long triangular portion cut out of the edge, some other manœuvres are requisite. Placing herself upon the leaf, the caterpillar cuts out with her jaws the piece which is to compose her roll. She does not, however, entirely detach it; it would then want a base. She detaches that part only which is to form the contour of the horn. This portion is a triangular strap, which she rolls as she cuts. When the body of the horn is finished, as it is intended to be fixed upon the leaf in nearly an upright position, it is necessary to elevate it. To effect this, she proceeds as we should with an inclined obelisk. She attaches threads, or little cables, towards the

point of the pyramid, and raises it by the weight of her body."

Other larvæ form their habitations wholly of silk: one that inhabits the leaves of pear-trees forms a little tent; another a sort of cloak; another, as in the case of the silkworm, a complete ball of silk.



PENDULOUS NESTS OF CATERPILLARS.

Among leaf-rolling caterpillars, one of the most curious is described by Bonnet, in which the

nest hangs suspended from the branch of a fruit-tree by a strong silken thread. It is formed of one or two leaves neatly folded and fastened together with silk, and in this small inclosure several caterpillars live harmoniously together.

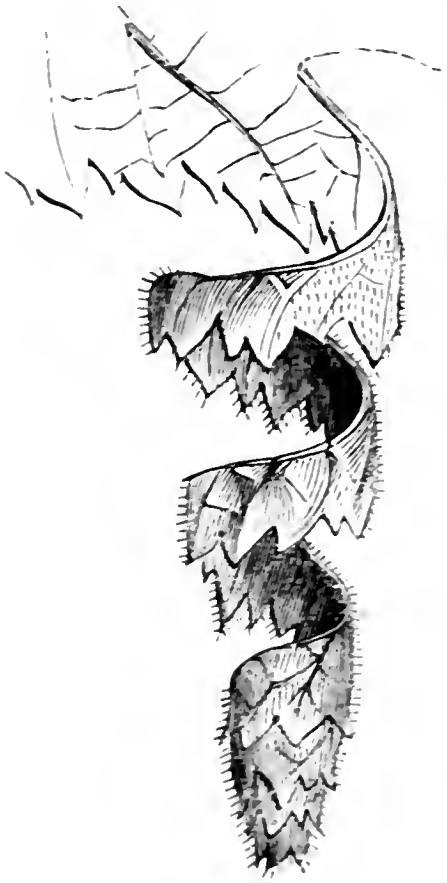
There is also a very curious and beautiful nest formed by a rare insect, which has only yet been observed in its caterpillar state; but its proceedings therein are interesting and highly remarkable. The length of the body in this caterpillar varies from six to eight inches, the thickness is half a line. The general colour is bluish green, tending to yellow about the head; the feet are black, and six in number. At the extremity of the body are two points projecting sideways. The eyes are visible and prominent in this caterpillar, and besides the antennæ there are two or three pairs of palpi or feelers, which perform the office of hands. This insect inhabits the nut-tree, and cuts out from its leaves a most ingenious case, which serves for its dwelling-place. This case is of a singular form, being an elongated cone, very narrow at the extremity, and tolerably wide at the

orifice. It is formed of a strip of nut-leaf, wound up in a spiral manner, but so cleverly contrived

LEAF CUTTING CATERPILLAR.

that the strip is very narrow at the extremity, and gradually widens as the work proceeds. This happens from the gradual progress of the work, which is begun in the early stage of the caterpillar's existence, when it does not require a large dwelling-place, and becomes more and more extended to suit the growth of its inmate. When

it is completed, it is rather more than an inch long, and two lines in diameter at the orifice. The outside of the case presents the upper surface of the leaf in which the indentations are preserved. The dwelling is a spacious one for the caterpillar, so that it can turn round in it with perfect ease. The band of which the cone is composed is taken from the edge of the leaf, which the caterpillar cuts away in proportion as it winds it round its own body. When one portion has taken the required form, a little more is cut out, but always in a direction parallel with the edge of the leaf. While the insect is thus gradually rolling itself up in a case, it also feeds vigorously on the leaf, taking care, however, always to spare the band which forms its habitation. Another part of the cleverness of this



LEAF-NEST UNWOUND.

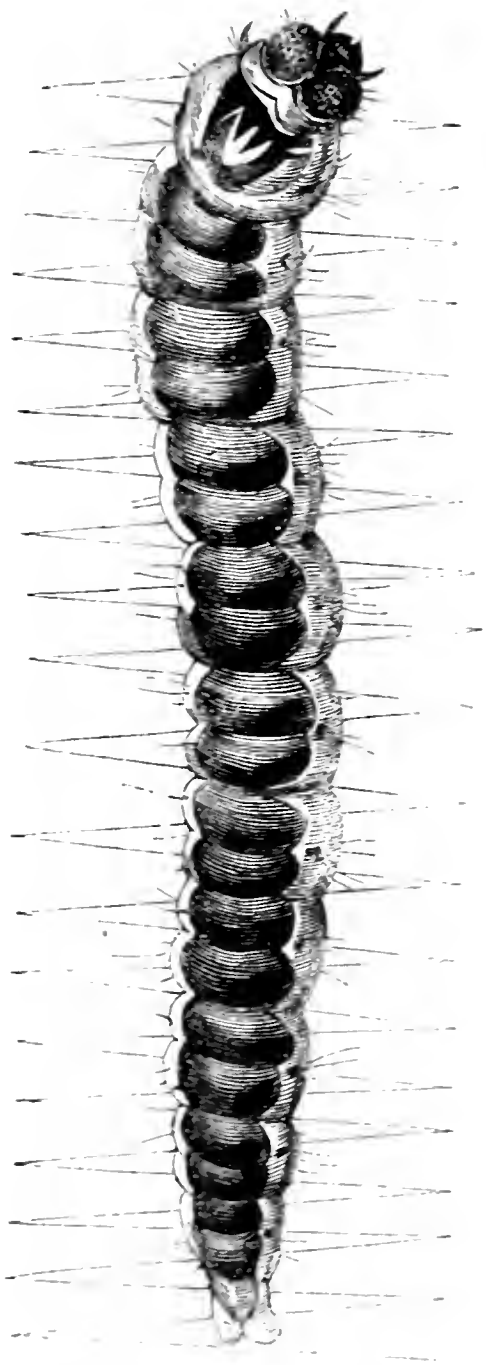
insect consists in maintaining this strip of leaf in its spiral form, which would otherwise naturally unwind by its own weight, and flutter in the wind as a torn fragment. Here it is that silk is again skilfully employed. The caterpillar commences much as other leaf-rolling insects do, by fastening a thread to the edge of the leaf and drawing it towards the desired point. But as the work proceeds the insect generally has three skeins or bands of silk extended from the opening of its case to the leaf. The first is the shortest and the most direct, issuing from the interior of the roll; the second is fastened to the middle of the last spiral, and extends to the leaf; the third is more extensive still, and all three are admirably disposed for keeping the leaf bent to the proper form. These skeins are composed of a great number of threads parallel with each other, which not only serve to retain the leaf in its spiral form, but also serve the caterpillar as a kind of ladder, by which it mounts, and on which it rests while cutting out fresh portions of leaf.

It sometimes happens accidentally to this cater-

pillar that the case becomes detached from the leaf, or naturalists have purposely severed a portion to see what would be the result; but this does not greatly disturb the insect, for as long as a single thread of silk remains to hold the pieces together, the caterpillar is able to repair the evil. It will unite the fractured portion almost imperceptibly by means of silken threads, and proceed with its case as before; but if the leaf dry up and wither, the insect is then compelled to desert it, and to select a younger and fresher leaf for its operations.

What is still more curious, on the completion of the dwelling, the caterpillar sometimes wishes to make an excursion to another part of the leaf, and to take its house with it, and this it accomplishes in the following manner. Coming more than three parts out of the cone, the creature makes new skeins in advance of the old, and attempts to pull the cone forward by their means; but finding that this does not succeed, it bends its body back, and quickly severs the old threads and the portion of leaf which keeps the case

immovable. It is now able to draw the case onwards a certain distance, after which it has only to repeat the operation, and make other new skeins in advance of these, to continue its onward journey. Thus it arrives at the opposite edge of the leaf, where it carefully adjusts its case to the under side, fastening it with great ingenuity, and drawing the threads tighter where the cone is not properly balanced. In all these cases, silk is the useful material by which the caterpillar secures its nest, and provides for its own safety: it is also a constant resource in case of danger, or of accident, as the following anecdote will show. A caterpillar of the goat-moth, being confined in a smooth glass sugar-basin, managed to crawl up the slippery sides and escape. This excited great surprise in the naturalist (Rösel) who had imprisoned the creature, and he therefore took occasion closely to watch its proceedings when again placed in a similar vessel. It was with surprise and admiration that he now saw the caterpillar constructing a silken ladder on the side of the glass; the natural gum of the silk being sufficient to secure it even to

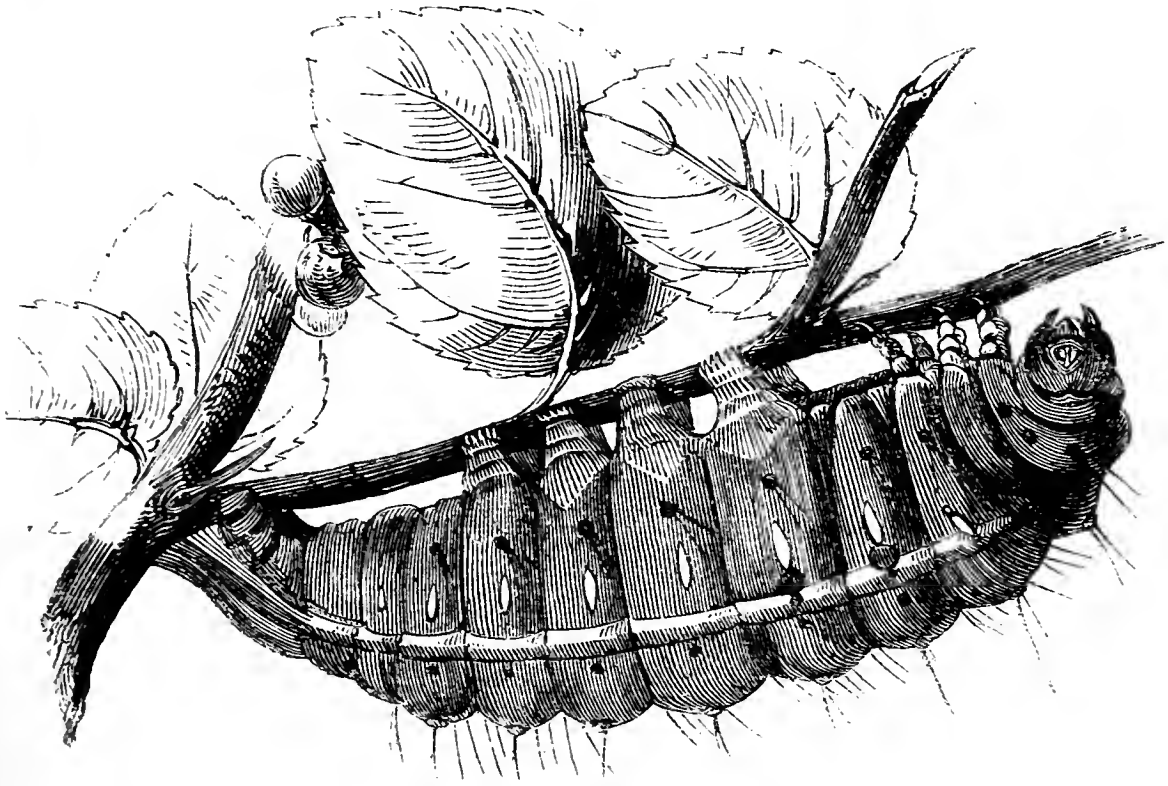


SILKEN LADDER SPUN BY THE GOAT-MOTH CATERPILLAR.

that perfectly smooth surface. Up this ladder the creature crawled, and thus easily and expeditiously made its escape.

Silkworms abound in our own country, as well as in others; but the silk they spin is too fragile and scanty to be employed for other purposes than their own. It is different with some of the caterpillars of India. Although the great supply of silk is there obtained, as with us, from the silkworm of the mulberry tree, yet the caterpillars of various moths also furnish a considerable quantity. The most important of these are the *Tusseh* and *Arindy* silkworms, both natives of Bengal. The

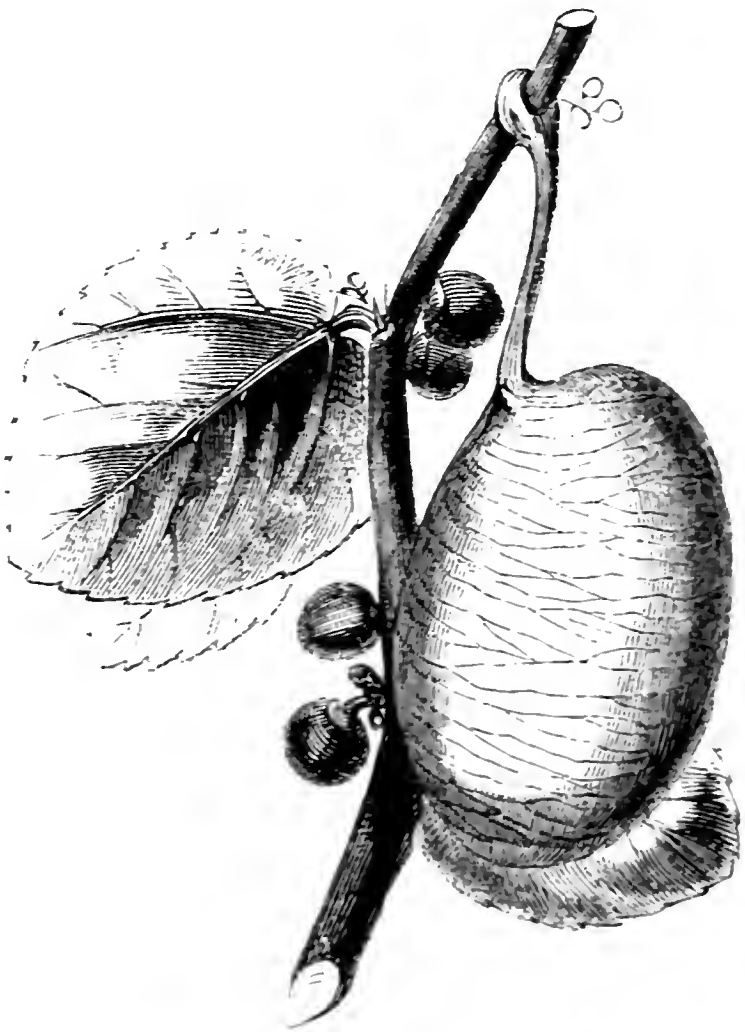
first feeds on the leaves of the jujube tree and of the asseen, and is found in such abundance as from time immemorial to have afforded a constant supply of coarse, dark-coloured silk, which is woven into a cheap but very durable cloth.



THE TUSSEH SILKWORM.

When the caterpillars approach their full size they are too heavy to crawl in search of their food with the back upwards, as is usual with most caterpillars, but traverse the small branches suspended by the feet, as is shown in the figure.

When the caterpillar is ready to spin its cocoon, it connects by means of the silk, (which is always glutinous when newly spun,) two or three new leaves into an outer envelope, which serves as a



COCOON OF THE TUSSEH SILKWORM.

basis to spin the complete cocoon in, besides the cocoon being suspended from a branch of the tree

in a wonderful manner, by a thick, strong, consolidated cord, spun of the same material by this persevering creature.

The cocoon is of an exact oval shape, and very firm in texture: in it the animal remains dormant, and perfectly protected, for about nine months, namely from October until July; so that it makes its appearance in time for the caterpillars to come into existence, when Providence has furnished them with the greatest plenty of proper food. When the insect is prepared to make its escape and be changed into its perfect state, it discharges from its mouth a large quantity of liquid, with which the upper end of the case is so perfectly softened as to enable the moth to work its way out in a very short time; an operation which is always performed during the night. In their perfect state these insects do not exist many days: the female deposits her eggs in the branches of the tree she may be resting on, to which they adhere firmly by means of the gluten they are covered with when newly laid.

The eggs are white, round, and compressed,

with a depression in the centre on each side. They hatch in from two to four weeks, according to the state of the weather. The *larvæ* or caterpillars acquire their full size, which is about four inches in length, and three in circumference, in about six weeks: they are nearly the colour of the leaves they feed on, with a light yellowish stripe on each side; under these stripes the middle segments are marked with an oblong gold-coloured speck. The back is also marked with a few round darker coloured spots, from which issue a few long, coarse, distinct hairs, while others of smaller size are scattered over the insect.

The Tusseh silkworm is found in such abundance over many parts of Bengal and the adjoining provinces, as to afford to the natives a large supply of the durable coarse, dark-coloured silk, already mentioned, commonly called Tusseh silk, which is woven into a kind of cloth called Tusseh doot'hies, much worn by Brahmins and other sects of Hindoos. This substance would no doubt be highly useful to the inhabitants of many parts of America and the south of Europe, where

a cheap, light, cool, durable dress, such as this silk makes, is much wanted. Millions of cocoons of the Tusseh silkworm are annually collected in the jungle, and brought to the silk factories near Calcutta. In other parts the people gather and transplant them to the trees near their own dwellings, that they may watch over the safety of the caterpillars, which are very liable to be devoured by crows during the day time, and by bats at night.

The Arindy silkworm feeds only on the leaves of the Palmi Christi; it produces so delicate and flossy a silk that it cannot be wound from the cocoons; it is therefore spun like cotton, and the thread woven into a coarse kind of white cloth, of a loose texture, but so durable that a person can scarcely in his lifetime wear out a garment made of it.

Eleven different species of silkworm have been enumerated as natives of India, which has thus the internal means of providing the whole of Europe with a material which would rival cotton and woollen cloth, and would often be preferred to both, could it be obtained at a low price. The produce of the Arindy silkworm, when sent to this country was much admired, and some manufacturers to

whom it was shown seemed to think that they had been hitherto deceived in the account of the shawls of India being made from the wool of a goat, and that this silk, if sent home, could be made into shawls equal to any manufactured in India.

Many of the larvæ of the European moths afford a very strong silk, and it is said, that a manufacture of silk from the cocoons of the emperor moth was at one time established in Germany. There is no doubt, however, that silk might be collected in abundance from many native silkworms in America. Cocoons have been described eight inches long, made of grey silk, which the inhabitants of Chilpancingo, Tixtala, and other places in South America, manufacture into stockings and handkerchiefs. Humboldt also observed similar nests in the provinces of Mechoacan, and the mountains of Santa Rosa; they were of dense tissue, resembling Chinese paper, of a brilliant whiteness, and formed of distinct and separate layers. The interior layers, which are the thinnest, and of extraordinary transparency, were used by the ancient Mexicans as writing tablets.

CHAPTER II.

MANUFACTURE OF SILK BY THE SILKWORM.

We now come to the most important of all silk-spinning insects, the common silkworm, or caterpillar of the mulberry tree moth. The labours of this insect were known and appreciated in other parts of the world long before we had tidings of its existence; so that the peasantry of other lands were clad in raiment which our kings would have been proud to wear. "When silk was so scarce in this country that James the First, while King of Scotland, was forced to beg of the Earl of Mar the loan of a pair of silk stockings to appear in before the English ambassador, enforcing his request with the cogent appeal, 'for ye would not, sure, that your king should appear as a scrub

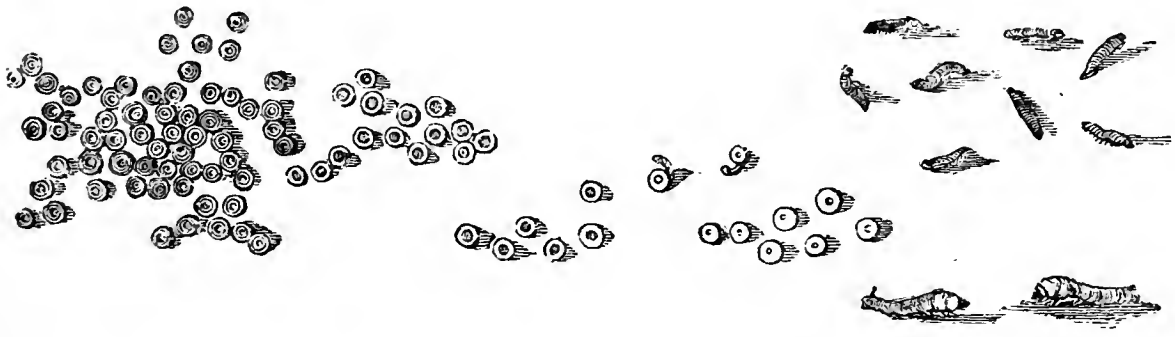
before strangers;' nay, long before this period, even prior to the time that silk was valued at its weight in gold at Rome, and the Emperor Aurelian refused his empress a robe of silk because of its dearness, the Chinese peasantry in some of the provinces, millions in number, were clothed with this material; and for some thousand years to the present time, it has been both there and in India (where a class whose occupation was to attend silkworms appears to have existed from time immemorial, being mentioned in the oldest Sanscrit books,) one of the chief objects of cultivation and manufacture. You will admit, therefore, that when nature

> —— Set to work millions of spinning worms,
> That in their green shops weave the smooth-haired silk
> To deck her sons,

she was conferring upon them a benefit scarcely inferior to that consequent upon the gift of wool to the fleecy race, or a fibrous rind to the flax or hemp plants; and that mankind is not under much less obligation to Pamphila, who, according to Aristotle, was the discoverer of the art of

unwinding and weaving silk, than to the inventors of the spinning of those products."

It is so common an amusement with young persons in this country to procure the eggs of silkworms, rear the insects, and watch their changes that numbers are acquainted with the growth, habits, and manner of spinning of these interesting creatures. Perhaps a sheet of paper is given to a little boy or girl, on which are a number of small specks, no bigger than pins' heads: these



EGGS AND SILKWORMS IN THE FIRST AGE.

specks, the child is told, are silkworms' eggs, and if he keeps them dry during winter, and then places them in a sunny window in spring, he will get a number of caterpillars from them

Taking care to do this, the child is delighted some fine morning to see a few little dark coloured worms crawling about the paper, while others are just issuing from the eggs. Perhaps a difficulty now arises about their food. In warm countries the leaves of the mulberry-tree are ready for the insects as soon as they are hatched; but in England, unless the eggs are purposely kept back, by putting them in a cold place, the caterpillars come out before the mulberry-tree has put forth its leaves. A few tender leaves of the lettuce are therefore spead lightly over the young caterpillars, and upon these they mount, and at last begin to feed, after searching in vain for their natural food. But the worms do not thrive on this diet, and it is much better so to manage the eggs that they may be hatched when the young leaves of the mulberry are just opening. These form the best possible food in that tender state, and in order to economise it, the leaves should be cut in small pieces; because the caterpillars feed only on the edges, and thus great part of a leaf, when given to them whole, is entirely wasted.

THE WHITE MULBERRY.
(*Morus alba.*)

In Italy, where great attention is paid to the cultivation of the silkworm, the eggs are hatched

in a room heated by a stove, and the young caterpillars are then removed on their mulberry-leaves to a cooler apartment called the nursery, where they are managed with great care and skill. Wicker shelves are arranged in the room at convenient distances, and are lined with paper, on which the worms are placed. Care is taken to place together only such worms as are hatched at the same time, for without this precaution the treatment, with respect to food, could not be regulated, and the moultings would not take place at the same time. Great care is also taken to secure the worms from rats and mice, as well as from certain insect enemies.

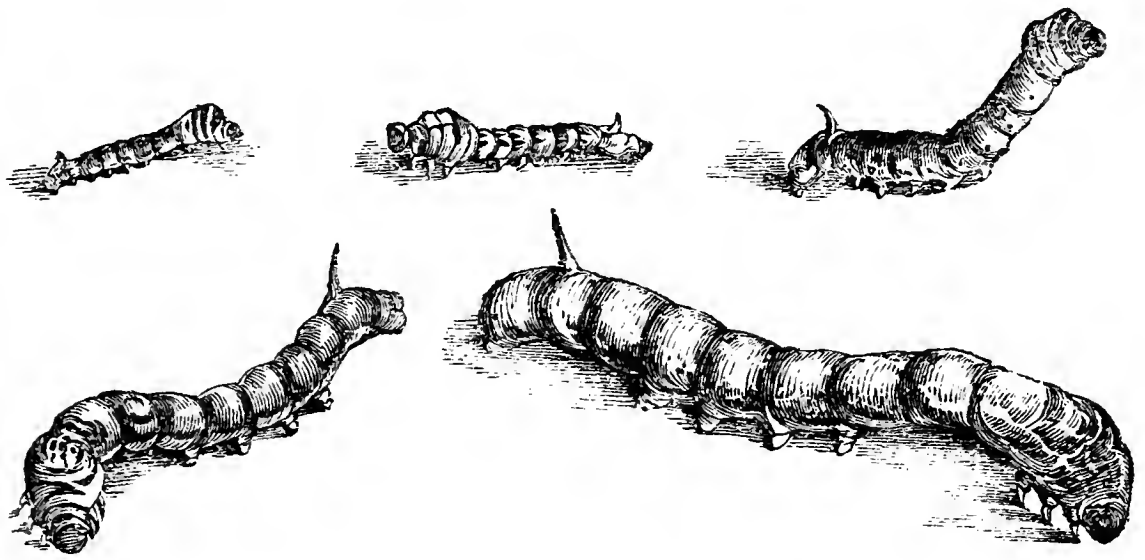
Silkworms are so little disposed to wander away from their food that open trays are sufficient to secure them: but unless great cleanliness is observed in their management, and frequent change of food given, a sickly smell is observed, and the caterpillars languish and die in great numbers. Supposing the young brood goes on well, and is properly attended by the child whom we have supposed to undertake the charge, there will be

about five or six days' feeding, and then the worms will begin to sicken for their first moult, or casting the skin. Silkworms have four of these moults, at each of which they appear to suffer pain or inconvenience; they also entirely leave off eating for two or three days. The caterpillars at that time raise the fore part of their bodies, and show tokens of uneasiness. They have grown rapidly, and their skins, not having grown in proportion, now appear to press and inconvenience them; but after two or three days fasting, they become thinner and are able gradually to rid themselves of their skin. It is now that their owner may see the use they begin to make of their silk. By watching them closely he sees each caterpillar throw out a number of very fine silken lines, by which it fastens the skin to one spot. Having done this, it is able to creep out, without dragging the skin about after it, as would otherwise be the case. In this operation the whole covering of the body, including that of the feet, of the jaws and teeth, is cast off; but it sometimes happens

that the animal cannot entirely cast its skin, a portion of it breaking and remaining attached to the extremity of the body. As the animal increases rapidly in size, this portion of the old skin compresses its body tightly, causing inflammation and much suffering, which usually ends in death.

Worms that have newly moulted are readily distinguished by their pale colour, and the wrinkled appearance of the new skin. Soon after moulting they recover health and vigour, and feed with increased appetite. To keep them in health they must be fed with great regularity, and not crowded together in their trays. In the course of five days the rapid growth of the insect causes the wrinkles to disappear from the skin; it is now half an inch in length; a second sickness, and a second moulting, prepare it for increase of growth; it casts its skin as before, and feeds without intermission during another five days, during which time it attains a length of three quarters of an inch. It then falls sick and moults a third time.

It again feeds during five days, after which it casts its skin for the fourth and last time in the caterpillar state.



PROGRESSIVE GROWTH OF THE SILKWORM.

It is now about one and a half or two inches in length, and devours its food most voraciously, increasing rapidly in size during ten days. When the worms are fed a slight hissing noise is heard similar to that of green wood burning. According to some writers this noise proceeds from the action of the jaws, but others attribute it solely to the action of the feet, which are continually moving until the worms have fastened to their food, when the noise ceases. In a large nursery

of silkworms this noise sounds like a soft shower of rain.

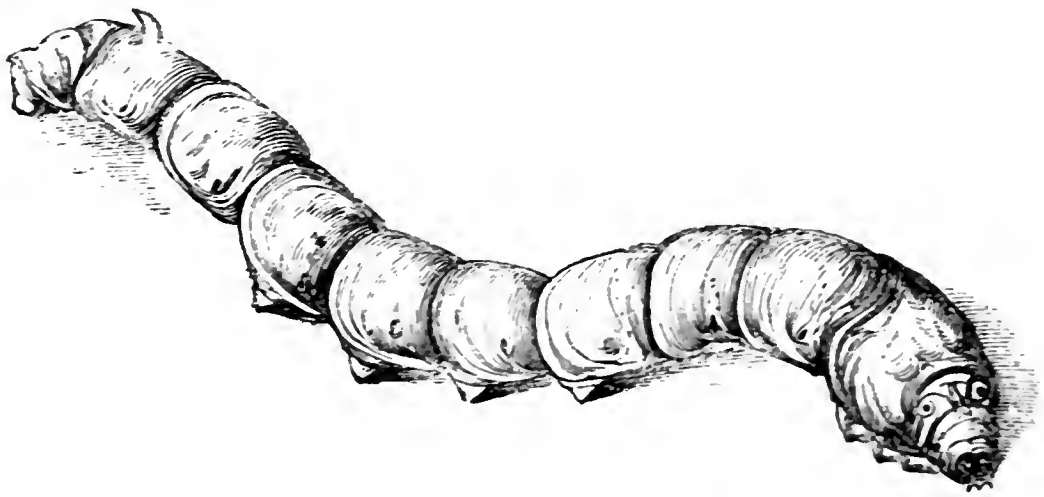
SILKWORM ON MULBERRY-LEAF.

When the caterpillar has attained its full growth, it is a very different creature from the little black worm which first issued from the egg, being from two and a half to three inches in length, and its body consisting of twelve membranous rings,

which contract and elongate as the animal moves. It is furnished with sixteen legs, in pairs: three pairs in front, under the first three rings, are covered with a shelly or scaly substance; the other five pairs, called holders, are furnished with little hooks, which assist the insect in climbing. The head is covered with a scaly substance similar to the covering of the fore legs. The mandibles are of great strength, and indented like the teeth of a saw. Beneath the jaw are two small openings, through which the insect draws its silken lines. The substance of which the silk is composed is a fine yellow transparent gum, secreted in two slender vessels, "which are wound, as it were, on two spindles in the stomach; if unfolded, these vessels would be about ten inches in length." The insect breathes by means of eighteen holes or spiracles, distributed along the body, nine on each side. On each side of the head, near the mouth, are seven small eyes; the two specks higher up on the head, which are generally mistaken for eyes, are only parts of the skull.

When the silkworm is ready to spin, it gets

upon the leaves without eating them, rears its head as if in search of something, or crawls to the edges of the tray and moves slowly along; its rings draw in, and its greenish colour changes to a deep golden hue; its skin becomes wrinkled about the neck, and its body feels like soft dough, and on taking it in the hand, and looking through



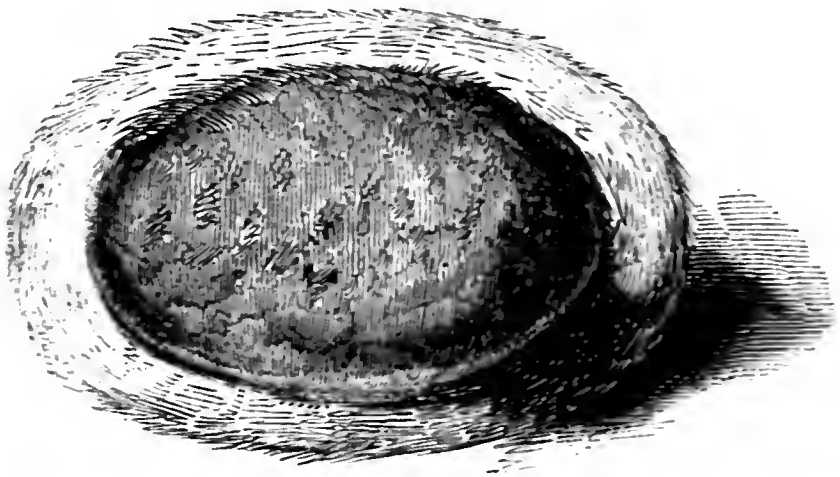
FULL GROWN SILKWORM.

it, the whole body has assumed the transparency of a ripe yellow plum. When this is observed, the owner of the insects puts each singly into a little cone of white paper, which he pins to the wall or elsewhere, so that the creature may be undisturbed at its work. But in the nurseries abroad little bushes are set up on the wicker

shelves, and the insects mount them and form their cocoons among the twigs.

Supposing the worm to be left to itself on the tray, without either of these precautions, it at last selects some corner or hollow place which will conveniently hold the cocoon it is about to spin, and begins by throwing out a number of irregular threads, which are intended to support its nest. Upon these it forms, during the first day, a loose structure of floss silk of an oval shape, within which, during the next three days, it winds the firm, hard, yellow ball, remaining, of course, all the time within it. In this operation the insect does not greatly change the position of the hinder part of its body, but continues drawing its thread from various points and attaching it to others, so that after a time the body becomes to a great extent enclosed by the thread. "The work is then continued from one thread to another, the silkworm moving its head and spinning in a zigzag way, bending the fore part of the body back to spin in all directions within reach, and shifting the body only to cover with silk the part which

was beneath it. As the silkworm spins its web by thus bending the fore part of the body back, and moves the hinder part of the body in such a way only as to enable it to reach the farther back with the fore part, it follows that it incloses itself in a cocoon much shorter than its own body, for soon after the beginning the whole is continued



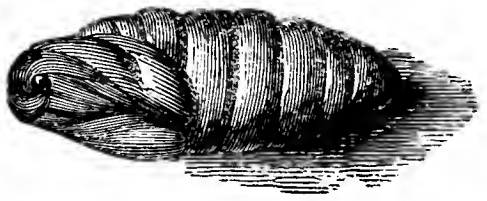
THE COCOON,
(A portion of the floss silk has been removed.)

with the body in a bent position. From the foregoing account it appears that with the most simple instinctive principles all the ends necessary are gained. If the silkworm shifted its position much at the beginning of the work, it could never enclose itself in a cocoon; but by its mode of

proceeding, as above explained, it encloses itself in a cocoon which only consumes as much silk as is necessary to hold the chrysalis."

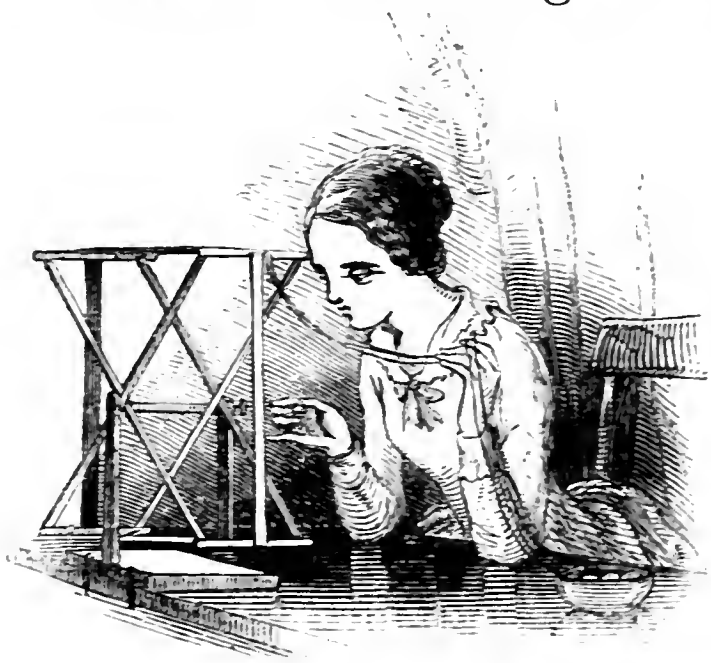
The use of the cocoon, in the natural state of the insect, is to afford a warm nest, where, secure from the inclemencies of the season, and the attacks of enemies, it may undergo its final changes. The cocoon is made water-tight by an internal lining of gum, and the silken thread of which the ball is made is also smeared with a similar gum, which hardens in the air.

While the worm is spinning its cocoon it takes no food, and as it is continually emitting silk, its body gradually diminishes to less than half its original length. When its labour is completed it rests awhile, and then once more throws off its skin; but it is no longer a caterpillar; its form is changed into a chrysalis, or aurelia, with a smooth brown skin, and pointed at one end. A few days after the insect has finished spinning, the cocoons will be ready to be unwound. Our amateur silkworm



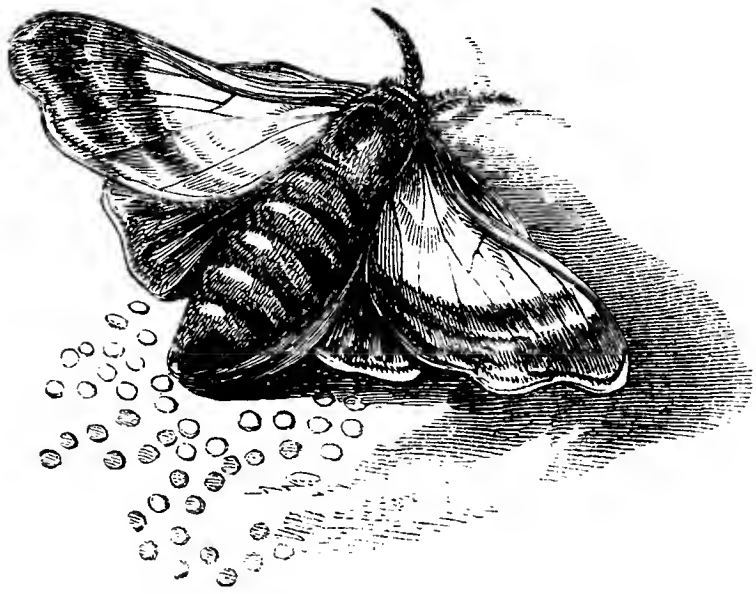
THE CHRYSALIS.

cultivator then takes the cocoons out of the paper cones and separates the outer floss silk. He then throws several cocoons into a glass of water slightly warm, to make them more easy to unwind, and having found the ends, proceeds to wind the silk on a reel, or he gives the task to a sister's gentler hands, while he prepares a little box of bran, in readiness to put the poor exposed chrysalis the moment it is released from the cocoon. As the winding proceeds, the cocoons become thinner and thinner until the insects within are visible. The chrysalis, though covered with a horny skin, and apparently without much sensation, shows very plainly that it is sensible of the rough treatment it is receiving, as the cocoon is tossed about in the water by the motion of the reel. It rapidly moves the rings of its tail, which is doubt-



GIRL WINDING SILK.

less a sign of uneasiness or pain. When nearly all the silk is wound off, there still remains a transparent film like silver paper, which is torn open to let out the chrysalis. The latter is immediately buried in bran, where it remains very quietly for a week or two, then changes into a cream-coloured moth, lays its eggs, and dies. This is the common domestic treatment when silkworms are kept for amusement, but in a commercial establishment such as those of Italy, they are very differently treated.



FEMALE SILKWORM MOTH AND EGGS.

The cocoons are collected in large quantities, separated and sorted according to their quality, about one-sixtieth part being saved for the production of eggs, after which the life of the chrysalis is destroyed in all the rest. This is done in

hot countries by exposure to the sun; but in more temperate climes by artificial heat, such as that of an oven after the bread has been withdrawn. Before the cocoons can be reeled they must be separated from the floss, which is done by opening the floss covering at one end and pushing out the cocoon. Care is taken in reeling to use cocoons of one quality, as different qualities require a different treatment.

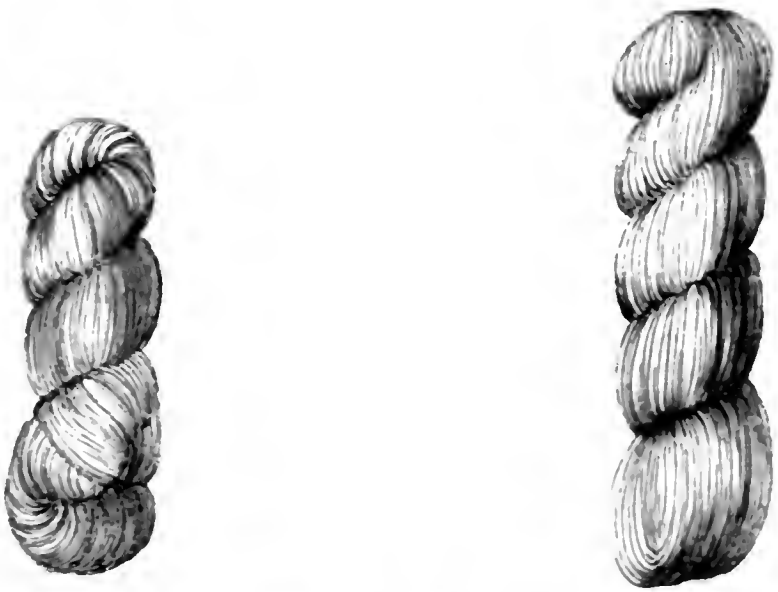
The natural gum of the cocoons is first softened in warm water, kept at the proper temperature, either by a charcoal fire or by a steam pipe. After remaining in this for a few minutes, the reeler (generally a woman) gently stirs up or brushes the cocoons with a short birch rod, and to this the loose threads of the cocoons adhere, and are thus drawn out of the water: they are then taken commonly four or five together, twisted with the fingers into one thread, and passed through a metal loop, to get rid of dirt and impurities: the thread then passes on to the reel, which is so constructed as to have a slight lateral motion, so that the thread of one revolution does not overlay the

other; for if it did so, the threads would be glued together before the gum had had time to harden by exposure to the air. The threads of the four or five cocoons are thus united into one strong and smooth thread. Sometimes as many as thirty cocoons are united into one thread, and it is difficult to wind more. As often as a thread of any single cocoon breaks or comes to an end, the attendant supplies its place by a new one, so that by continually keeping up the same number the united thread may be wound to any length: these joinings are not made by a knot, but the new end is simply laid on the compound thread, to which it adheres by its gum; and as the threads are finer near their termination than at the commencement, it is necessary for the reeler to add other cocoons before the first set is quite exhausted; so that the compound thread may be of uniform thickness. The filaments of three fresh cocoons, added to two half-wound ones, make a thread about equal to that from four fresh cocoons. The cocoons are not entirely wound off, but the husk containing the chrysalis is used together with the floss silk under the name of

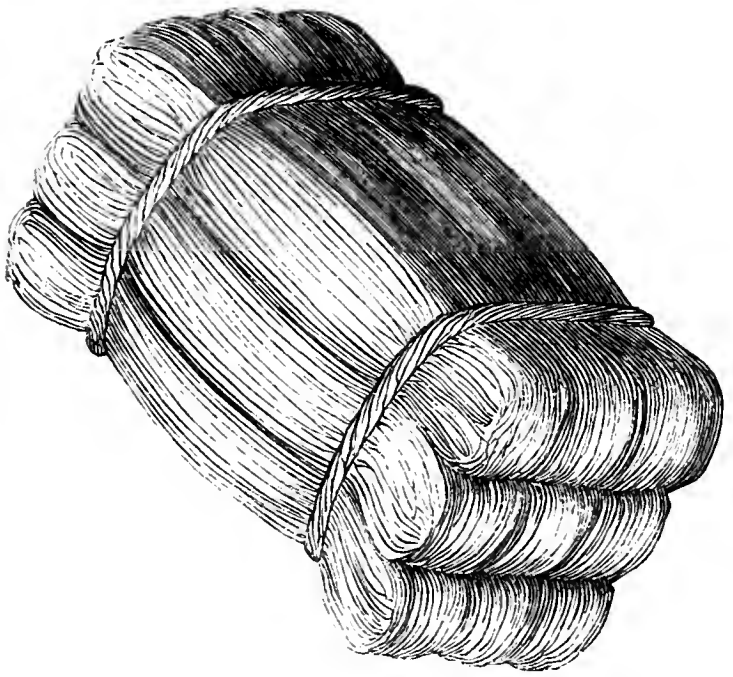
waste. Improved methods of reeling have been introduced on the continent, but they are similar in principle to the above.

Eleven or twelve pounds of cocoons yield about one pound of reeled silk; and as from 240 to 250 cocoons weigh a pound, the number of cocoons required to produce a pound of silk may be estimated at 2,817½. The length of filament yielded by a single cocoon is 300 yards, but some have yielded as much as 625 yards.

The reeled silk is made up into hanks for sale or use. The form and contents, as well as quality, of these hanks, differ greatly, as will be seen by the following wood-cuts.



HANKS FROM ITALY.



BOOK OF SILK FROM CHINA.

SLIP FROM BENGAL.

We may aptly conclude our account of this most industrious silk-manufacturer in the words of the Rev. Samuel Pullein, M.A., who, so long ago as 1758, wrote an Essay on the Culture of Silk, in which the following passage occurs:—

"There is scarce anything among the various wonders which the animal creation affords more admirable than the variety of changes which the silkworm undergoes; but the curious texture of that silken covering with which it surrounds itself

when it becomes a moth, and arrives at the perfection of its animal life, vastly surpasses what is made by other animals of this class. All the caterpillar kind do indeed undergo changes like those of the silkworm, and the beauty of many of them in their butterfly state greatly exceeds it; but the covering which they put on before this change into a fly is poor and mean, when compared to that golden tissue in which the silkworm wraps itself. They indeed come forth in variety of colours, their wings bedropped with gold and scarlet, yet are they but the beings of a summer's day; both their life and beauty quickly vanish, and they leave no remembrance after them; but the silkworm leaves behind it such beautiful, such beneficial monuments, as at once record both the wisdom of their Creator, and His bounty to man."

On the importance of the silk itself, Kirby and Spence have the following remarks:—

"To estimate justly the importance of this article, it is not sufficient to view it as an appendage of luxury unrivalled for richness, lustre, and

beauty, and without which courts would lose half their splendour; we must consider it what it actually is, as the staple article of cultivation in many large provinces in the south of Europe, amongst the inhabitants of which the prospect of a deficient crop causes as great alarm as a scanty harvest of grain with us; and, after giving employment to tens of thousands in its first production and transportation, as furnishing subsistence to hundreds of thousands more in its final manufacture, and thus becoming one of the most important wheels that give circulation to national wealth."


THE
GEOMETRIC
SPIDER

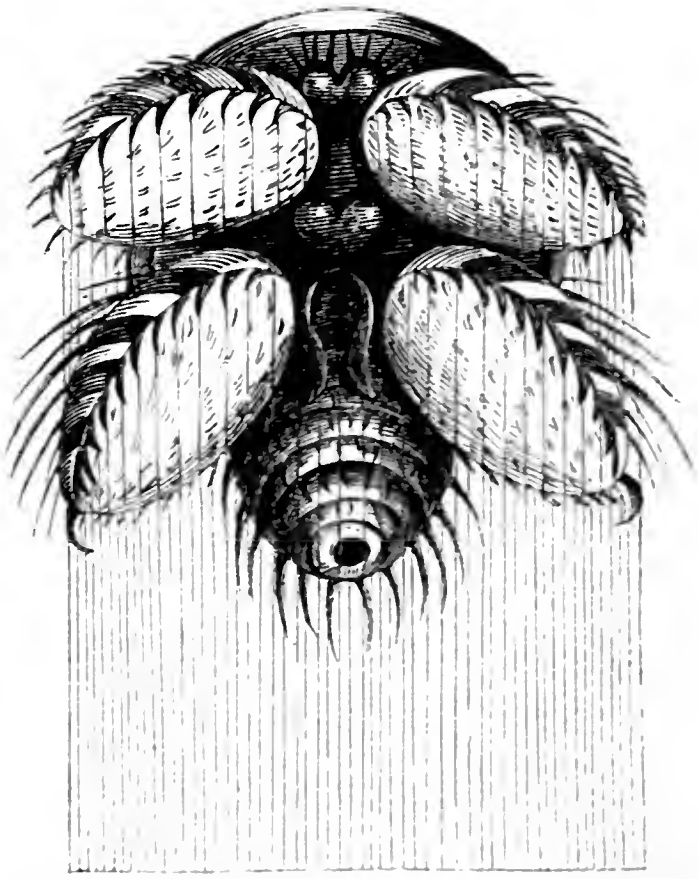
CHAPTER III.

MANUFACTURE OF SILK BY SPIDERS.

Our history of the silk manufacture among insects would be incomplete without a notice of the labours of spiders. Not only do these insects produce filmy webs to entrap their prey, but they also spin, for the protection of their eggs, a bag not much unlike the cocoon of the silkworm. At the beginning of the last century a method was discovered of procuring silk from these spiders' bags, and of making it into several useful articles. The experiments took place in France, and it was there discovered that two species of spider in particular produced strong and beautiful silk, capable of being usefully employed. The structure of these insects was closely examined by the cele-

brated naturalist Réaumur, and he found that the silk is spun from five papillæ, or small nipples, placed in the hinder part of the body; these serve the purpose of so many wire-drawing irons, to mould a gummy liquor, which dries as it is drawn out and exposed to the air.

On pressing the body of a spider, the liquor flows into these nipples, by applying the finger against which, distinct threads may be drawn out through the numerous openings; and, what is very astonishing, every separate thread is made up of innumerable smaller threads, so that Réaumur thought himself far within the limits of the truth when he stated that each of the five



SPINNING APPARATUS OF THE SPIDER.
(*Greatly magnified.*)

nipples supplied one thousand separate fibres, in which case the slender filament of the spider's nest must be made up of five thousand fibres. By applying the whole, or a part, of this apparatus to her work, the spider can make the thread stout or fine at pleasure: thus the webs for entrapping flies are very slight and fragile; but the nest for securing the eggs is much stronger, to afford them shelter from the cold. The threads are wound loosely round the eggs in a shape similar to that of the silkworm's cocoon. The colour of the silk is generally grey, becoming blackish on exposure to the air: sometimes it is pale yellow, and also of very fine quality; but this is the production of comparatively rare species, which could not be depended on for the purposes of manufacture. A spider's nest preserved by the writer during the last winter was of a beautiful yellow, almost approaching that of the cocoon of the silkworm. As spring approached it increased in bulk and became rather paler, until at last a dark appearance in the centre betokened the bursting of the eggs.

At the present time (April 10th) ninety-six small yellow-bodied spiders have come forth, and are actively engaged in weaving their delicate webs across the glass which contains them. A muslin cover admits air to the interior, and these minute insects appear perfectly healthy although deprived of their natural food. Some sugar was placed in the glass, but they do not appear to have consumed any of it, although some of them have been hatched for more than a fortnight. From the appearance of the nest, more of these spiders yet remain to be hatched.

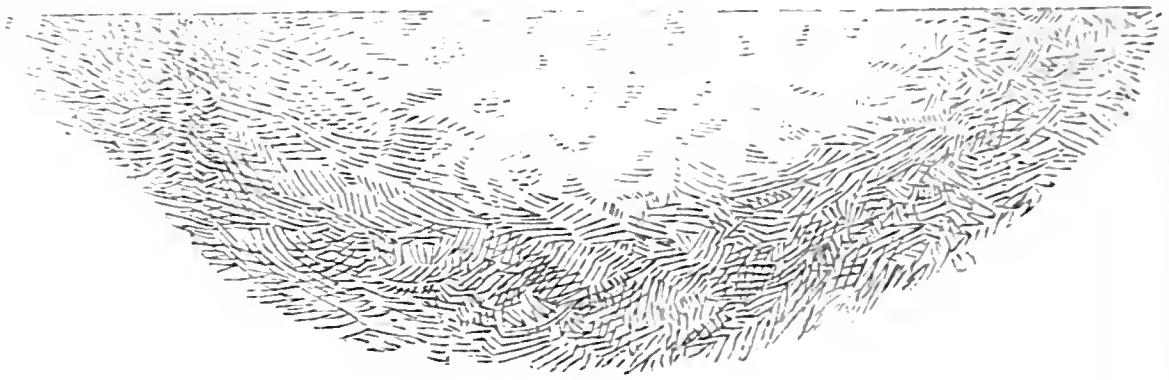
In the French experiments, spiders' nests in large quantities were collected from the trunks of trees, corners of windows and vaults, and eaves of houses at the time above mentioned, and from these a new kind of silk was obtained by M. Bon, who declared it to be in no respect inferior to that of the silkworm. It was afterwards proved that he was greatly mistaken in this respect; yet the spiders' silk readily took all kinds of dyes, and was actually wrought into

stockings and gloves, specimens of which were presented by M. Bon to the Royal Academy of Paris, and also to the Royal Society of London. His method of preparing the silk was as follows:—

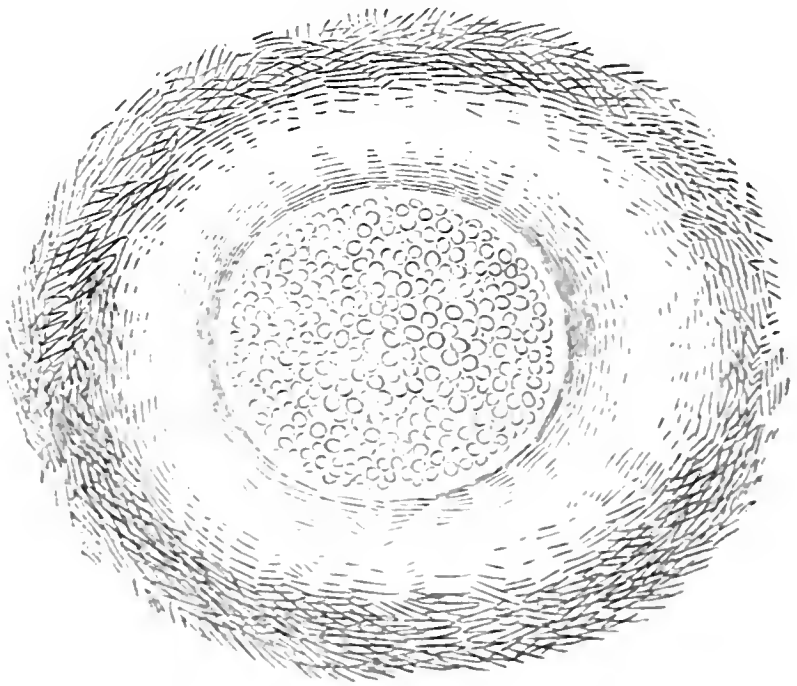
Twelve or thirteen ounces of the bags were beaten with the hand, or by a stick, until they were entirely free from dust. They were then washed in warm water, which was frequently changed, until it was no longer discoloured by the bags. They were next steeped in a large quantity of water, wherein soap, saltpetre, and gum-arabic had been dissolved. The whole was then set to boil over a gentle fire for three hours. Lastly, the bags were rinsed in clear warm water, and set out to dry. They were then fit for the operation of carding, which was performed with very fine cards, and thus silk of a peculiar ash colour was obtained, which was spun without difficulty.

The great obstacle which prevented the establishment of any considerable manufacture from these spiders' bags, was the difficulty of obtaining them in sufficient abundance; but M. Bon, who

was enthusiastic respecting the value of his discovery, fancied that he could easily overcome this



SPIDER'S NEST ATTACHED TO A FLAT SURFACE.



SPIDER'S NEST LAID OPEN.

obstacle, and at first his efforts appeared remarkably successful. He formed a large spider esta-

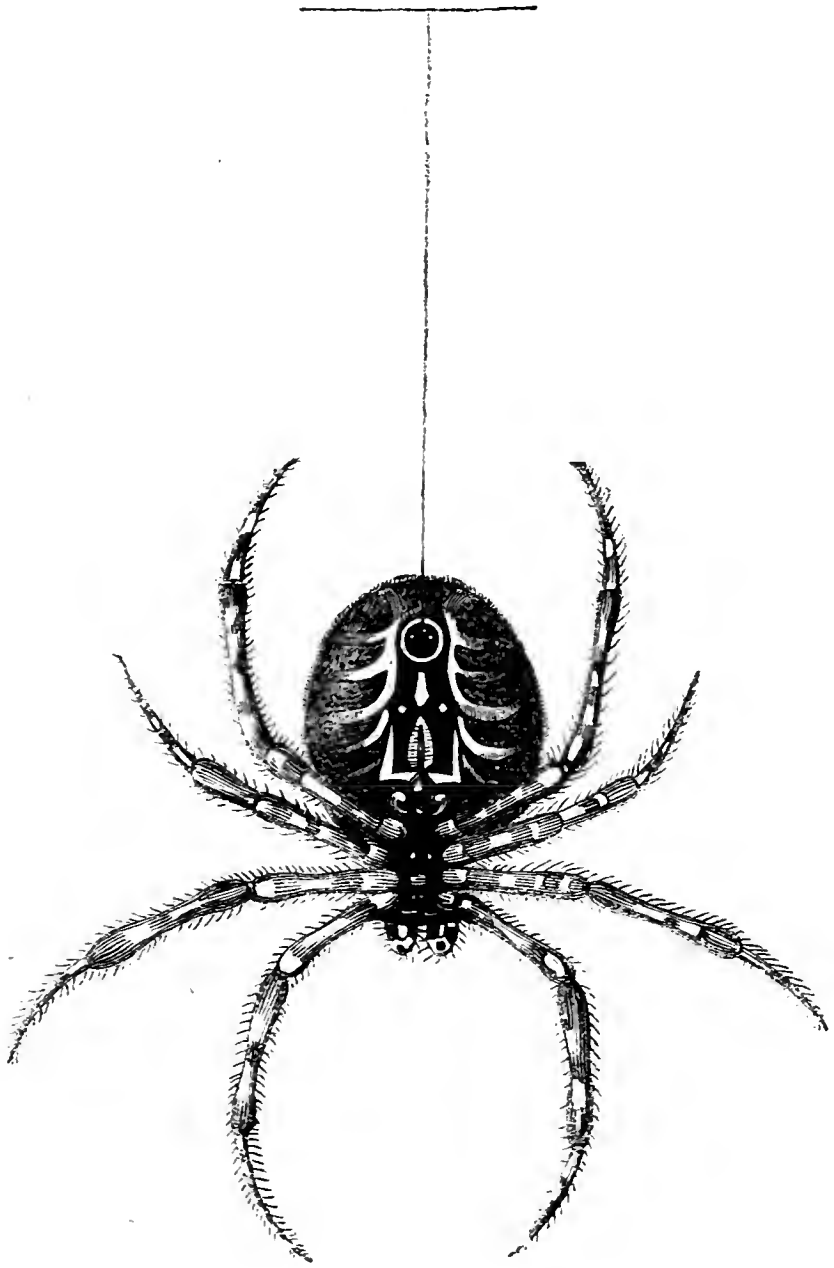
blishment, which, for a time, was very prosperous. Having ordered all the short-legged spiders (which are the most industrious spinners) to be collected for him by persons employed for the purpose, he enclosed them in paper boxes, with pin-holes pricked in them to admit the air to the prisoners. The insects were regularly fed with flies, and prospered well on their diet. In due time most of them laid their eggs, and spun their silken bags. M. Bon affirmed that each female produced from six to seven hundred eggs, whereas the silk-worm moth lays only about one hundred. He also stated, that out of seven hundred or eight hundred young spiders which he kept, scarcely one died in a year; while of one hundred silk-worms, not forty lived to form their cocoons.

These favourable statements led the Royal Academy of Paris to take the subject into consideration, and Réaumur was appointed to inquire into the merits of the new scheme. This careful inquirer found many serious obstacles in the way of such establishments. The fierceness of spiders, and their propensity to destroy each other, were

noticed as unfitting them to be bred and reared together. On distributing about five thousand spiders in cells, in companies of about fifty or a hundred, it was found that the larger spiders quickly killed and ate the smaller, until there were only one or two occupiers of each cell. The silk of the spider was also found inferior in lustre and strength to that of the silkworm, and had the disadvantage of being incapable of winding off the ball, but must necessarily be carded.

Indeed, it could require no very great consideration to decide, that spiders' silk, when compared with that of the silkworm, was vastly inferior for manufacturing purposes, though employed in many useful and highly ingenious ways by the insect itself. A few of these we must not omit to notice. Every one must have seen the common garden spider (*Epeira diadema*) suspended by its silken rope, or forming its beautiful web; but every one is not aware that that silken rope is made up of a multiplicity of threads, and that when the spider attaches the rope to any object by pressing her spinneret against it, she spreads

out these threads over an area of some diameter,



GARDEN SPIDER—*(Natural Size.)*

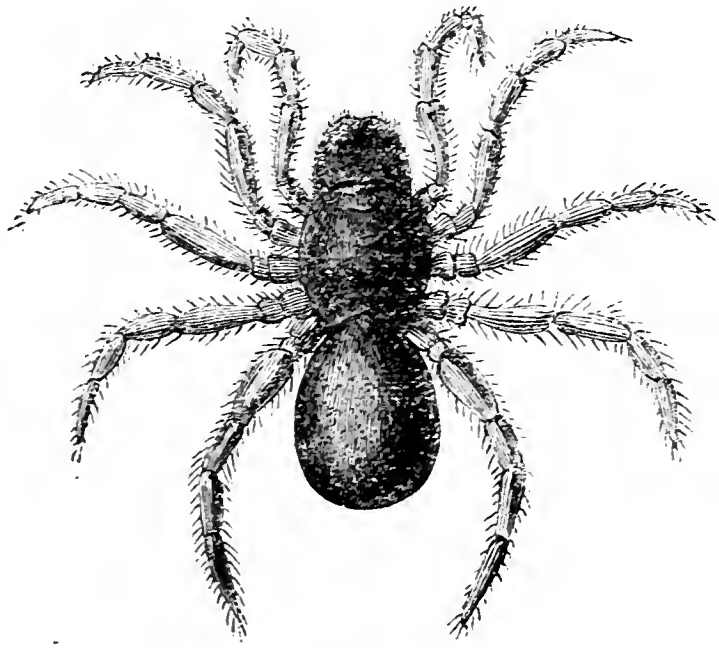
thus securing a much greater degree of strength than could be gained by merely fixing her thread

to one point. This contrivance may be seen best when the threads are attached to a black object. Under the microscope they appear thus:—

SPIDER'S METHOD OF ATTACHING HER THREAD.

The uses of silk in the webs and nests of common spiders are too obvious to be dwelt on, but there is a most clever and surprising adaptation of the same material by several foreign species of spider which must be briefly stated. In the Ionian islands, and also in the West Indies, there are found certain spiders, commonly known as trap-door spiders, which make a cylindrical nest in the earth, and cover the entrance with a door of their own construction, framed of alternate layers of silk and earth, and fastened to the opening by a hinge of stout silk. These spiders also line their nests throughout with numerous layers of silken web to the thickness of stout cartridge paper, and finish

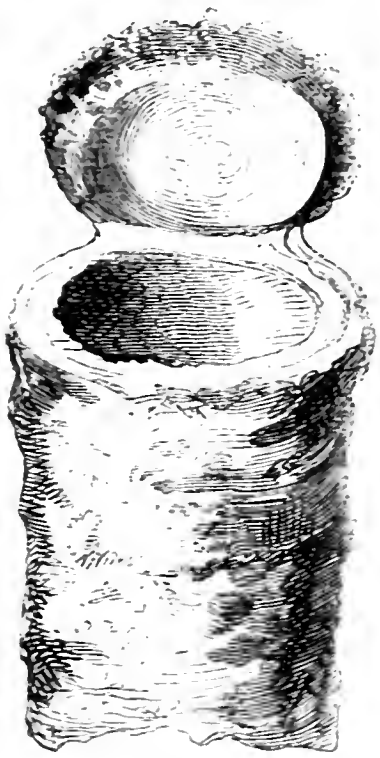
it with the greatest care. This beautiful lining is yet further strengthened in particular parts, where the nest is likely to be exposed to danger. But the greatest amount of skill and care is bestowed upon the trap door and its silken hinge. This door is about the eighth of an inch thick, rough on the outside, not much unlike an oyster shell, which it also resembles in being thick and strong



TRAP-DOOR SPIDER.

near the hinge, but thinner towards the circumference. The breadth of this hinge is various, but sometimes it is very considerable, as shown in the accompanying figure. It also possesses great

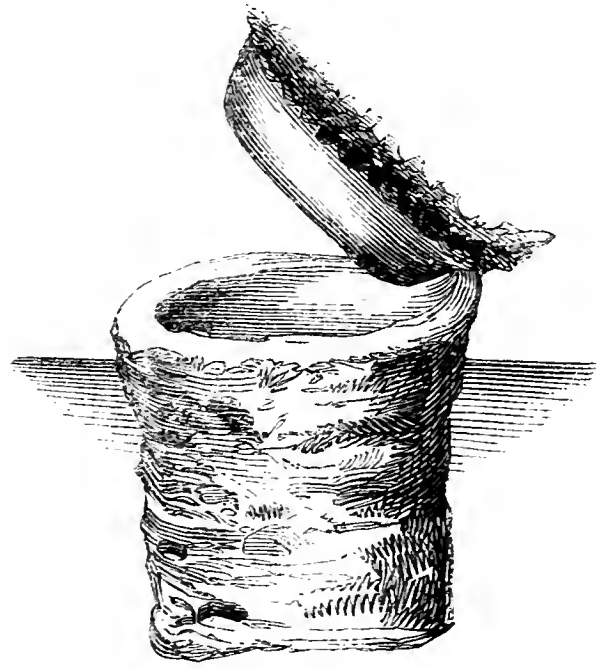
elastic force, so that on being opened, it closes again of itself. This is principally accomplished by a fold or doubling of the web, at each end of the hinge, which permits the door to be opened nearly to a right angle with the aperture, but no farther, unless violence be used. The under side of the door is perfectly smooth and firm, being shaped so as to fit accurately, and yet to offer no resistance when pushed open by the insect.



NEST OF TRAP-DOOR SPIDER.

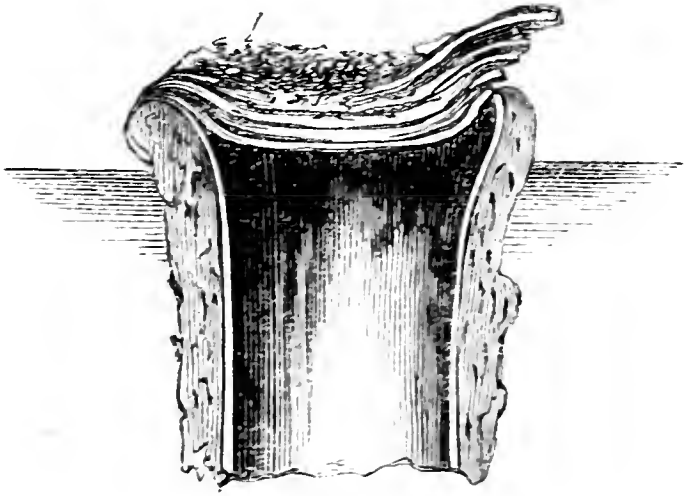
As might be expected, there are varieties in the shape and size of these nests. Some specimens found in the island of Zante had the silken layers of the lid extended into a sort of handle or lever just above the hinge, on pressing which in ever so slight a degree the trap-door opened. From this it would appear that the entrance to such a nest could be effected as easily by the enemies of the spider

as by the spider itself: this, however, is not the case; for repeated observation has shown that the spider keeps guard at the entrance, and actually holds the door with her fore feet and palpi, while the hinder feet are extended down the side of the nest, and the mandibles are thrust into the opposite side near the door. By this means the insect gets such power as to resist with considerable force the opening of the door. If it be asked how this is known, we are able to refer to the experiments of careful observers, who extracted a number of nests from the ground, and opening them at the lower end, looked up, and saw the spider so occupied. A sectional view of the nest will show that the curved form of the cover, and the shape of the side walls, must favour this



TRAP-DOOR OPENING BY A LEVER.

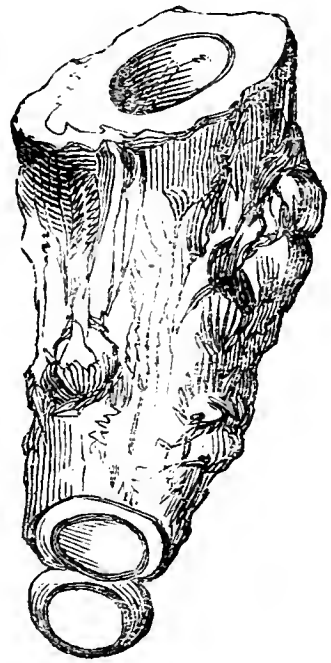
method of keeping the door shut. In some cases, small hollows were formed round the interior edge of the lid, into which the spider thrust its feet when keeping guard. It is a curious fact, that when several of these spiders enclosed in their nests were kept as a matter of curiosity in a box of earth, and the doors frequently opened to examine their proceedings, one or two of them, as if wearied at these repeated interruptions, effectually closed their doors by weaving a piece of silken tapestry, which was spread over the interior of the opening, and rounded like the inside of a thimble. This was so strongly attached to the door and to the side walls, that no opening could be made without destroying the nest.



SECTION OF NEST.

It was long a matter of surprise to the observer to find, that in the case of some nests, and not of

others, there was a trap-door at the bottom as well as at the top of the nest: this was at last explained by the following fact. A spider's nest, which was accidentally broken off in being extracted from the ground, was purposely restored to the earth in a reversed position, with the trap-door downwards, and the broken and exposed part level with the surface. The spider immediately set to work to make a new door over the broken part, and finished it with as much completeness as the other. Doubtless, then, those nests which were provided with two doors were such as had been upset and broken. This is the more likely because in Zante, where such nests were found, the earth is annually dug up round the roots of the olive tree, a favourite nesting place of these trap-door spiders.



NEST WITH TWO OPENINGS.

We must not omit to mention, that in some parts of South America, especially in Paraguay, there

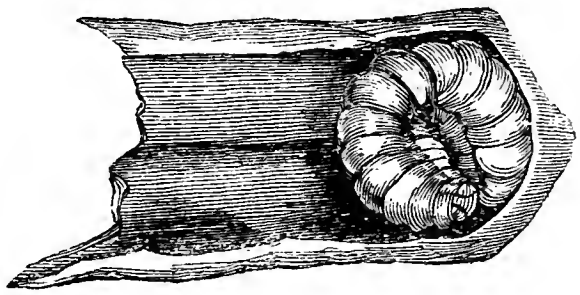
is a spider which forms a spherical cocoon for its eggs, an inch in diameter, of a yellow silk, which the inhabitants spin on account of the permanency of the colour. It must also be observed that the silk of spiders is useful to the astronomer, who employs the strongest thread (the one, namely, which supports the web) for the divisions of the micrometer. By its ductility, this thread acquires about a fifth of its ordinary length.

WHITE WAX INSECT OF CHINA.

CHAPTER IV.

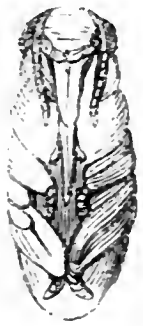
MANUFACTURE OF WAX BY THE HIVE BEE, THE HUMBLE BEE, AND THE WHITE WAX INSECT OF CHINA.

THE most notable insect manufacturer, after the silkworm, is the common hive-bee, which is able to produce three distinct substances, honey, wax, and silk; the first two only being useful to mankind. Persons who have never seen bees in any other than their perfect state, and are unacquainted with the internal economy of the hive, will learn with surprise that the first appearance of this insect is that of a small straight worm, which rapidly increases in size until it touches the sides of the cell which forms its dwelling-place. It



GRUB IN CELL.

then coils itself up, until the extremities meet and form a complete ring. When it ceases eating, the nurse-bees seal up the cell, leaving the caterpillar to spin its cocoon in safety. The silken film in which the insect now begins to wrap itself, proceeds from a spinner, situated in the middle part of the under lip, and is composed of two threads, gummed together as they issue from the two orifices of the spinner. The caterpillar is employed during thirty-six hours in making its cocoon; three days after which it becomes a chrysalis. Over this chrysalis, or rather over the cell in which it is contained, the nurse-bees brood until the warmth of their bodies penetrates, and assists in producing the last change of the insect within. The cocoon, by degrees, becomes attached to the interior of the cell like a lining, and the bee, having its parts gradually unfolded, begins at length to cut its way through the cover of the cell. It is now a perfect bee, and capable at once of taking its part in the labours of the hive. These labours chiefly relate to food, shelter,



and care of the young. In the article of food, the bee is a most industrious collector of the sweet juices of flowers, which are converted into the luscious honey with which she stores her hive. She also collects pollen, as an ingredient in the

BEES GATHERING HONEY.

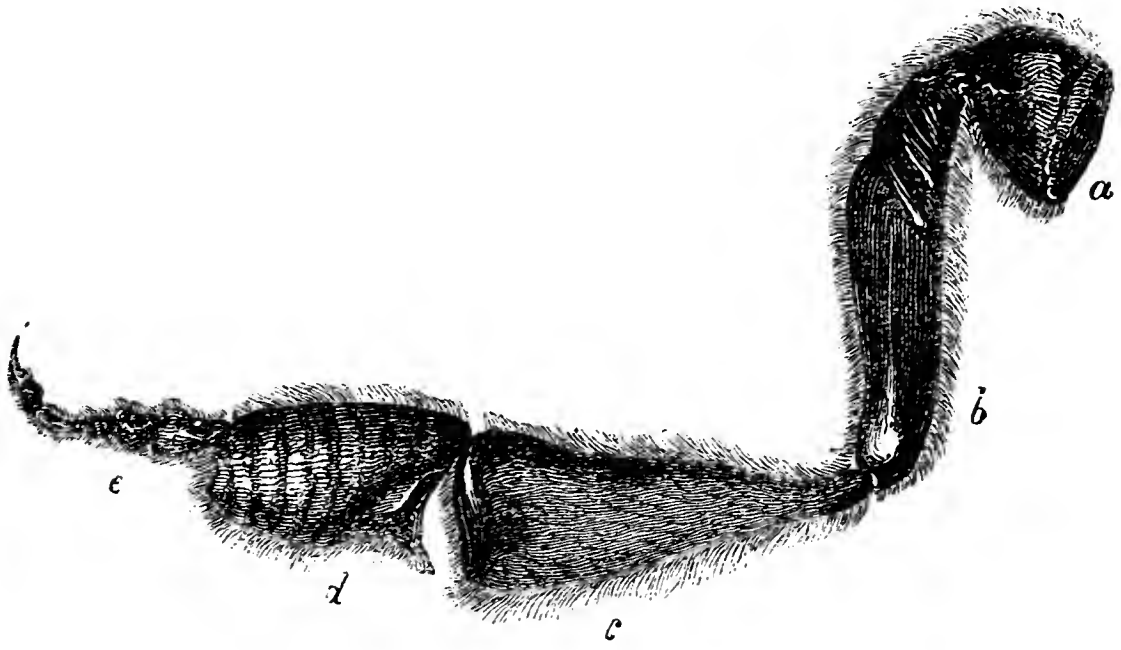
food of the young, and a gummy substance called propolis, which oozes from the poplar, birch, and

willow, and which she uses as a sort of varnish and cement to the projecting parts of the hive.

For the purpose of collecting, carrying home, and manufacturing these several products, the working bee is provided with a complete and beautiful apparatus, consisting of a *proboscis* (almost as wonderful in its way as that of the elephant), by which she ascertains the nature of food, and imbibes such as is adapted to her wants; a *honey bag*, or second stomach, which is a small transparent globe about the size of a pea, where she deposits her nectar; a *pair of baskets*, one in each hind leg, in which she stores the pollen of flowers, and the propolis or gum of trees; and lastly, in the case of the wax-makers, *four pairs of wax pockets*, or membranous bags, contained in the abdomen, where by some unknown process

HEAD OF BEE.
(*Magnified.*)

wax is secreted from the food taken into the



HIND LEG OF WORKER.

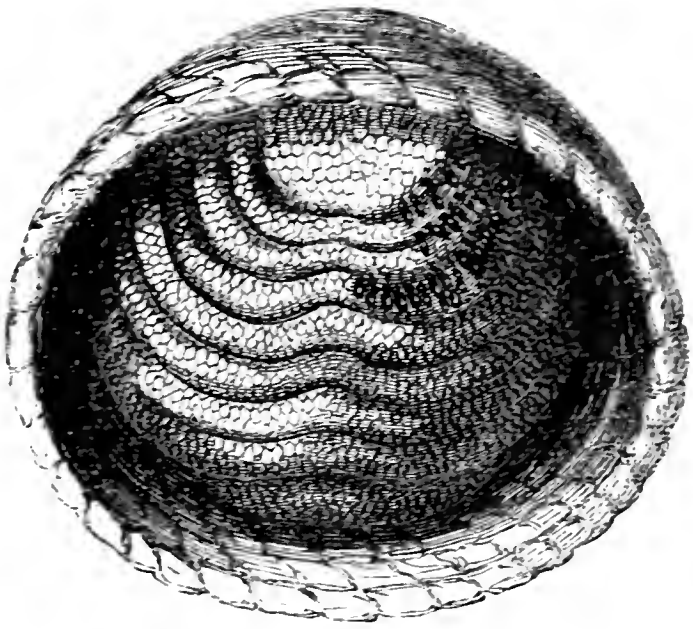
a, the haunch; *b*, the thigh; *c*, the tibia, or pallet, containing the basket or cavity; *d*, *e*, the foot.

stomach. What an astonishing provision for the requirements of a single insect!

THE MANUFACTURE OF WAX.

The honey-comb of a bee is a beautiful and highly curious object, and is composed of wax, a substance which man, with all his skill, is unable to fabricate. Whether the hive be natural or

artificial, the plan of its construction is much the same. A number of honey-combs, chiefly composed of *six-sided* cells, regularly applied to each other's sides, and arranged in two layers, are fixed to the upper part and sides of the interior of the hive. These combs are arranged at a small distance from each other, and the cells have their openings into the spaces between them, which are wide enough to allow two bees to pass each other easily. Besides these vacancies the combs are here and there pierced with holes, which serve as a means of communication from one comb to another, without losing time by going round.

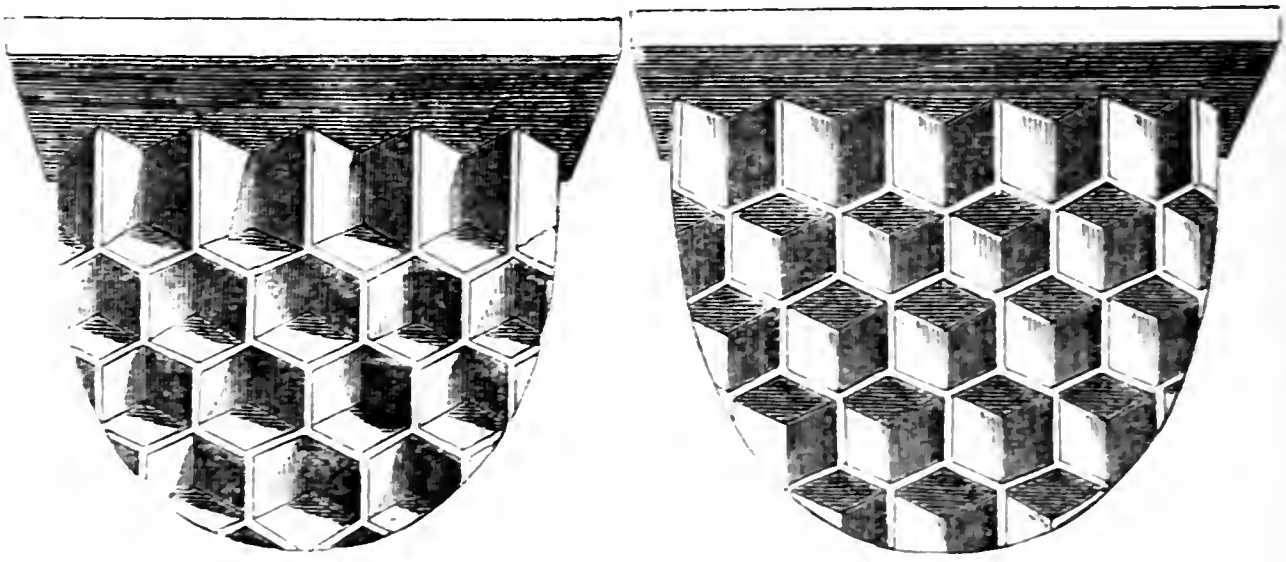


INTERIOR OF THE HIVE.

The cells being formed of wax, a substance secreted by the bees in no great abundance, it is important that as little as possible should be con-

sumed. Bees, therefore, in the formation of their cells have to solve a problem in geometry, namely, "a quantity of wax being given, to form of it similar and equal cells of a determinate capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space." Every part of this problem is practically solved by bees. If their cells had been cylindrical, which form seems best adapted to the shape of a bee, they could not have been applied to each other without leaving a number of useless vacant spaces. If the cells had been square or triangular, this last objection would be removed; but a greater quantity of wax would have been required, and the shape would have been inconvenient to a round-bodied animal. Hexagonal cells are admirably fitted to the form of the insect, at the same time that their sides apply to each other without the smallest vacant intervals. Another important saving in materials is gained by making a common base serve for two layers of cells. Much more wax as well as room would have been required,

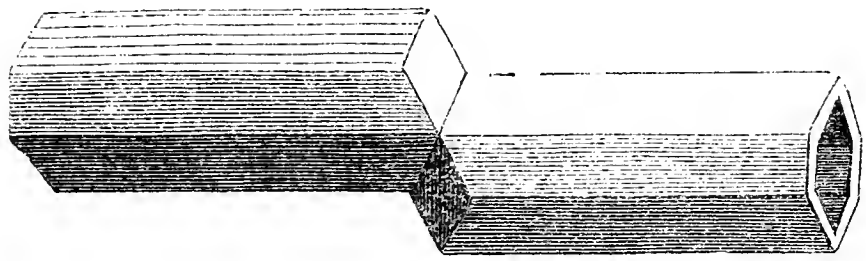
had the combs consisted of one layer only. But this is not all. The base of each cell is not an exact plane, but is usually composed of three lozenge-shaped pieces, placed so as to form a pyramidal concavity. From this form it follows that the base of a cell on one side of the comb is composed of portions of the bases of *three* cells on the other. By this arrangement a greater degree



FRONT AND REVERSE VIEW OF CELLS.

of strength is obtained, and also a more roomy cell, with less expenditure of wax. This has been clearly proved, as also that the angles of the base of the cell are exactly those which require the

smallest quantity of wax. It is obvious that these angles might vary infinitely; but by a very



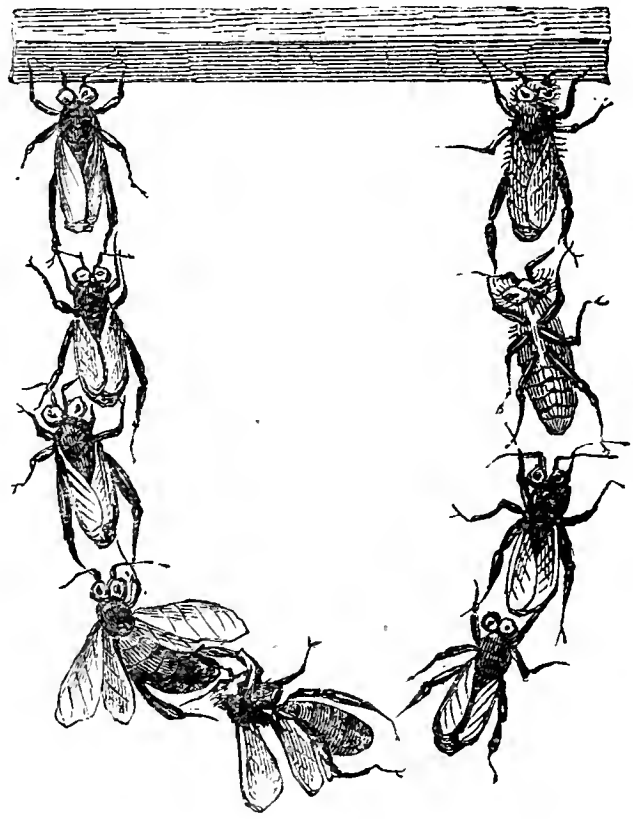
METHOD OF JOINING CELLS.

accurate measurement Maraldi found that the great angles were in general 109° 28′, the smaller ones 70° 32′. Réaumur, suspecting that the object of choosing these angles was to spare wax, proposed to M. König, a skilful geometrician, to determine by calculation what ought to be the angle of a hexagonal cell with a pyramidal bottom, formed of three similar and equal rhomboid plates, so that the least possible matter might enter into its construction. After an elaborate calculation, the geometrician found that the great angles of the rhombs should be 109° 26′, and of the small angles, 70° 34′, a surprising agreement between the solution of the problem, and the actual measurement.

The bees have also another contrivance for saving wax. They form the bottoms and sides of the cells of wax not thicker than writing paper; but as walls of this thinness at the entrance would be perpetually injured by the going in and out of the workers, they make the margin at the opening of each cell three or four times thicker than the walls.

It has already been said that wax is a secretion naturally formed in certain membranous bags in the body of the bee. As the secretion goes on, the wax oozes through the membrane, and forms in thin plates on the outside. The position adopted by the insects during this process is strange and almost ridiculous. Their proceedings are as follows:—The wax-makers, having taken a quantity of honey or sugar into the stomach, suspend themselves to each other, the claws of the fore legs of one being attached to those of the hind pair of another, until they form themselves into a cluster, consisting of a series of festoons or garlands, which cross each other in all directions, until they form a dense curtain, and in which

most of the bees turn their back upon the observer. In this position the wax-makers remain immovable for about twenty-four hours, during which period the secretion of wax takes place. At last one of them is seen to detach itself from the rest, and to make its way to the top of the hive, where it turns itself round, and clears a space of about an inch in diameter. It then seizes one of the plates of wax with a pincer, formed at the joints of the leg, and drawing it forwards, one of the fore legs takes it with its claw and carries it to the mouth. The insect then proceeds by means of its mandibles and its proboscis to reduce the plate to a riband of wax, which it softens with a frothy liquor. During

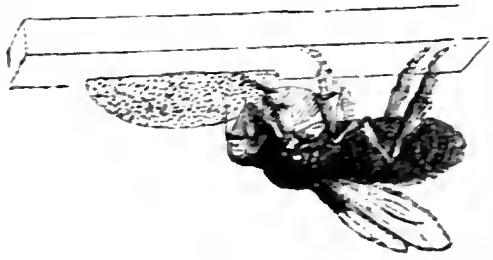


FESTOON OF WAX-MAKERS.

this operation the proboscis is sometimes flattened like a spatula, then like a trowel, at other times it is like a pencil, terminating in a point. The liquor mixed with the wax gives it a whiteness and ductility which it had not before, the object being to make it fit for working into any shape.

THE ROBOSCIS.

The parcels of wax thus prepared are applied against the vault of the hive, the little builder arranging them in the direction she wishes them to take: when she has thus employed the whole plate that she had separated from her body, she takes a second, and proceeds in the same manner. At length she leaves her work, and is lost in the crowd of her companions. Another succeeds, and resumes the employment; then a third: all follow the same plan of placing their wax; and if one by chance gives it a con-



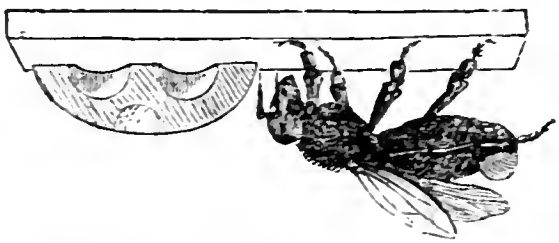
LAYING FOUNDATION OF CELL.

trary direction, another, coming after, sets it right. The result of all these operations is a little wall of wax, with uneven surfaces, five or six lines* long, two lines high, and half a line thick, which descends perpendicularly from the vault of the hive. In this first work there is no angle, nor any trace of the figure of the cells. It is a simple partition, in a right line, without any bend.

The wax-makers having thus laid the foundation of a comb, the nurse-bees come to model and complete the work. The former are the labourers, who convey the materials; the latter, the artists, who work them up into the required form. One of the nurse bees places herself horizontally on the vault of the hive, her head corresponding to the centre of the wall which the wax-makers have left, and which is to form the partition of the comb into two opposite assemblages of cells; and rapidly moving her head, she moulds with her jaws a cavity which is to form the base of one of the cells. When she has worked some minutes she departs,

* A line is the twelfth part of an inch.

and another takes her place, deepening the hollow, and heightening its sides by heaping up the wax to the right and left, by means of the teeth and fore feet. More than twenty bees successively employ themselves in this work. When arrived at a certain point, other bees begin on the yet untouched and opposite side of the mass, and commencing the bottom of *two* cells, are in turn relieved by others. While still engaged in this labour the wax-makers return, and add to the mass, increasing its extent every way, the nurse bees again continuing their operations. After having worked the bottoms of the cells of the first row into their proper forms, they polish them, and give them finish, while others begin the outline of a new series.



COMMENCEMENT OF CELLS

The cells themselves, consisting of six-sided tubes, are next constructed. The bees commence by making the edges of the cavities of equal height, so that all the margins of the cells offer an uniformly level surface. The sides are heightened in

an order similar to that which the insects follow in finishing the bottoms of the cells; and the length of these tubes is so perfectly proportioned, that there is no observable inequality between them. It is to be remarked, that though the general form of the cell is hexagonal, or six-sided, that of those first begun is an irregular pentagon, the side next the top of the hive, and by which the comb is attached, being much broader than the rest; whence the comb is more strongly united to the hive than if these cells were of the ordinary shape.

In giving the proper forms to the bottoms of the cells, the bees make much use of their antennæ, which extraordinary organs they seem to employ as directors, by which their other instruments are instructed to execute a very complex work. They do not remove a single particle of wax until the antennæ have explored the surface that is to be sculptured. By the use of these organs, which are flexible, and readily applied to all parts, however delicate, they can perform the functions of compasses in measuring very minute objects, and

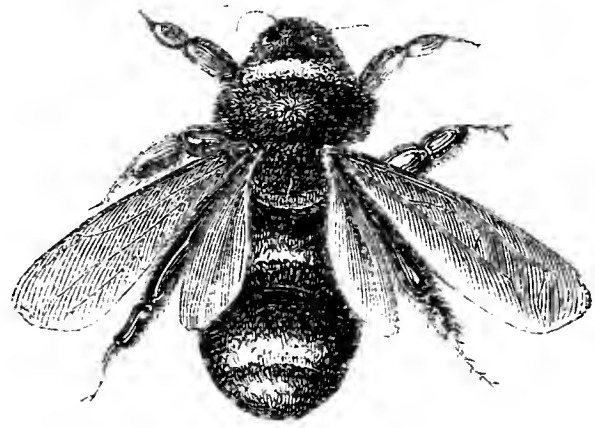
can work in the dark, and raise their wonderful combs.

All these proceedings are conducted with the utmost regularity. The original mass of wax is increased in a uniform quantity by the wax-makers, who merely produce and carry the materials, but have not the art of sculpturing the cells. Two masses of wax for combs are never begun at the same time; but no sooner are some rows of cells constructed in the first mass, when two other masses, one on each side of it, are established at equal distances from it, and parallel to it, and then again two more exterior to these. In a new hive the bees work with such rapidity, that in twenty-four hours they will sometimes construct a comb twenty inches long by seven or eight inches wide, and the hive will be half filled in five or six days; so that in the first fifteen days as much wax is made as in the whole year besides.

The commercial value of wax is considerable. A simple way of preparing it for use is as follows. When the hive has been cleared of honey, the wax is put into a woollen bag firmly tied at the mouth;

the bag is plunged into a pan of boiling water; the pure material oozes through the cloth, and swims upon the surface; it is carefully skimmed off, as long as any continues to rise, and poured into a shallow earthen bowl, which is previously wetted to prevent the wax from adhering to its sides. It must be allowed to cool very gradually, otherwise the cake which it forms will crack.

An inferior kind of wax is made by those large bees called humble bees, whose gay colours and booming flight make them so well known in our gardens.



FEMALE HUMBLE BEE.

Early in spring, as soon as the catkins of the willows are in flower, a large solitary female may be seen about them collecting honey and pollen. She is the only survivor of the former year's colony, and is the foundress of a new one. Her first care on awaking from her winter's sleep is to excavate a hollow in the earth for her nest, which

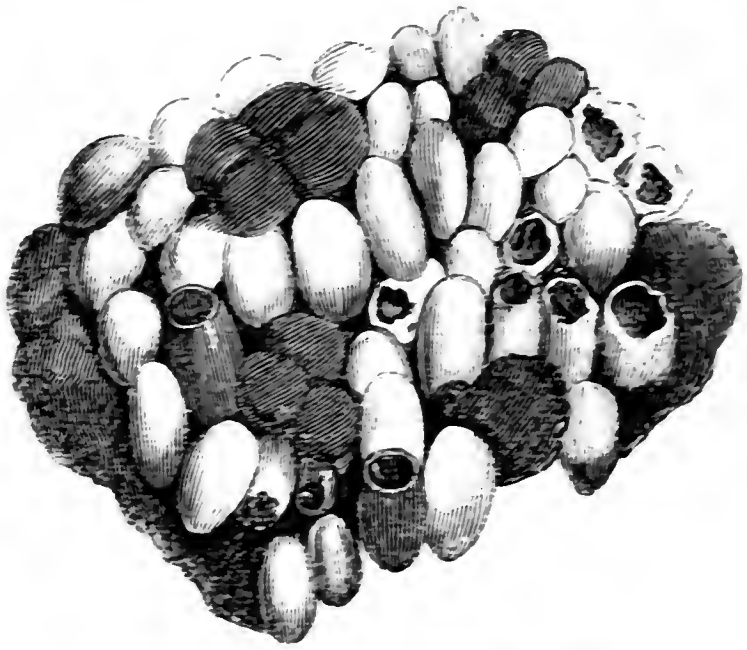
is often above a foot under the surface, and is entered by a passage or gallery. When complete, she lines it with soft leaves, and then proceeds to make her waxen cells. This she does so quickly,* that she can build a cell, fill it with honey and pollen, deposit one or two eggs in it, and cover them in, in little more than half an hour. A number of these cells are thus constructed; the eggs are hatched, and the little worms, increasing rapidly in size, at last spin silken cocoons, and undergo the usual changes. The workers are the most numerous portion of the population, and have abundant employment throughout the summer. One of their first cares is to line the roof of their nest with wax, to keep it warm and prevent water from filtering through. The wax of these insects is not so delicate, white, firm, or fusible as that of the

* The rapid formation of wax in the case of humble bees is very remarkable. Huber confined a number of them, and fed them during many days with pollen only; they produced no wax, constructed no cells, and laid no eggs; but on giving them honey, wax was produced in a few minutes, and the work of the colony proceeded.

hive bee, nor is it applied to such exquisite architecture; it is brown and soft, but well adapted to the rude works of their nest. It is formed in wax-pockets similar to those of the hive bee, and is moulded in plates to the shape of the insect's body. Unlike the queen of the hive, the foundress of this colony secretes wax, and does so even more abundantly than one of her workers.

The interior of a humble bee's nest has none of the beauty and regularity of the hive. Instead of a number of vertical combs of wax there is a confused and clumsy assemblage of egg-shaped bodies of dirty-coloured wax, placed one above the other, forming a series of horizontal combs, resting upon each other and connected by small pillars of wax. These egg-shaped bodies are of different sizes; those in the middle being the largest, closely joined to each other, and each group connected with those next it by slight joinings of wax. These oval bodies are the silken cocoons spun by the young larvæ; some are closed at the top, and include inmates; others, chiefly in the lower combs, are open, the young bees having escaped from them.

On the surface of the upper comb are several masses of wax of a roundish and irregular form,



CELLS OF THE HUMBLE BEE.

about an inch and a quarter in diameter and half an inch deep; these are brood cells, containing each six or seven large larvæ, lying close together upon a quantity of pollen and honey placed there for the purpose of nourishing them as soon as they are hatched. When the food is consumed, the workers make an opening in the top of the cell and introduce a new supply, taking care to seal up the cells again. The cells are sometimes split open as the grub increases in size, upon which the workers

fill up the cracks with wax, as fast as they occur. It is a curious fact, that these insects make use of the empty cocoons as honey-pots, first lining them with wax, and strengthening them round the edges with a waxen ring. Some nests contain as many as fifty or sixty of these honey-pots, containing stores for daily use, and which are never sealed over like the cells of the hive bee, because all the colony except one female dies at the approach of winter, and this solitary female lies in a torpid state during that season.

But bees are not the only wax-makers in the world. There is, in China, an insect called the white wax insect, which, in its caterpillar state, deposits a sort of wax on the branches of trees. Sir George Staunton tells us that accident led him to observe some swarms of uncommon insects busily employed upon the branches of a shrub, not at that time in fruit or flower, but whose leaves and general growth somewhat resembled our privet. These insects, not much bigger than common flies, were of curious structure, having an appendage to their bodies, in shape like the tail feathers of our

common fowl. This, as well as the whole body, was either perfectly white, or covered with a white powder, some of which was left in the track of the insect on the stems and leaves of the shrub. This was the early stage of the insect's life, and that in which wax is formed. The wax is described as being a greasy white substance when first deposited on the leaves and branches, where it soon hardens into a more compact form. The insect in its perfect state is of a blackish chestnut colour, and is furnished with wings. It deposits its eggs in little pellets about the size of a grain of millet, but these enlarge in the spring, and being attached to the branches, give to the shrub exactly the appearance of being loaded with fruit. About Midsummer these pellets open and disclose the insects, which soon begin to crawl about the branches and deposit wax.

It is in the autumnal months that the Chinese scrape the wax from the branches of trees, collecting it in a vessel, and then melting and straining it. They next coagulate it by pouring it into a vessel of cold water, and this gives it a pasty

form, in which it is easily made into cakes of the required size. This wax is exceedingly white and glossy, and when mixed with oil and made into candles, it is even superior for that purpose to the wax made by bees. Sir G. Staunton says that the product of these insects not only coagulates into wax, but will cause oleaginous substances to coagulate likewise, so that if one part of this wax be dissolved in three parts of heated olive oil, the whole, when cold, will coagulate into a mass, possessing a degree of firmness nearly equal to that of bees-wax. A Chinese writer states that it was not until the dynasty of Yuen that the wax made by these insects became known in China; but that as soon as its properties were ascertained, persons of all ranks began to use it, both in medicine and domestic economy. The medicinal qualities of the wax were much extolled by Chinese physicians, and a curious use of it is stated in Grosier's China, namely, that the Chinese orators, when about to speak in public and needing assurance, previously eat an ounce of this wax to prevent swoonings. But apart from virtues which

existed chiefly in the fancy of the Chinese, the uses of this substance in making candles, and for the ordinary purposes to which bees-wax is applied, are highly important. The wax, it is said, is carried to court and reserved for the emperor, the princes, and chief mandarins. The producing insects are found in most of the south-eastern provinces of China, as well as in Cochin China.

Nearly the whole of the wax employed in Europe, and the greater part of that consumed in America, is the produce of the common hive bee, but in the latter country the produce of wild bees is also extensively used. Wax forms an important branch of trade and commerce in all those countries where the Roman Catholic religion prevails, being extensively used in the festivals and rites of that church. According to Humboldt, wax to the value of eighty-three thousand pounds was formerly annually exported from Cuba to New Spain, where the quantity consumed in the festivals of the church is immense, even in the smallest villages. The total exports from Cuba in the year 1803 were worth upwards of 130,000*l.*

CHAPTER V.

MANUFACTURE OF HONEY BY THE HIVE BEE.

MANY and various are the trees, shrubs, and plants, yielding blossoms rich in honey, which have been recommended to be cultivated in the neighbourhood of bee-hives; and no one can have watched the proceedings of the industrious inhabitants without observing that the early blossoms of the sallow and of the horse-chestnut seem peculiarly acceptable, and later in the season those of the lime; while mignonette, thyme, rosemary, lavender, and various other flowers, are assiduously visited by these diligent collectors. But the best stores of our gardens yield a scanty supply compared with the treasures of the fields, such as bean blossoms, and clover blossoms. The latter

crop (especially the white Dutch clover called honeysuckle) is so rich in sweet juices, that when there is plenty of it, a good supply of honey is also pretty certain.

In autumn, bees attack fruit after birds or snails have removed the outer skin. They also consume *honey-dew*, the sweet fluid which is dropped by the aphis. At this season also the Passion-flower affords a seasonable supply of liquid honey. The fondness of the bee for the honey of this flower is thus noticed by Mr. Wailes in the *Entomological Magazine*. He says, "Against the south front of our house, several plants of the *Passiflora Cærulea* are trained, which cover it to the height of some twenty feet, or thereabouts; and, from July to November, the constant succession of its beautiful flowers attract great numbers of the hive-bee, especially during autumn, when flowers productive of much honey are scarce. Every one knows the passion-flower, and need hardly be told that one series of the rays of the nectary closely surrounds the stipes or shaft, whilst other two are beautifully spread over the horizontal leaves of the

THE PASSION-FLOWER.
(*Passiflora Cærulea.*)

corolla; but perhaps few are aware that the tube of the calyx contains several drops of pure and delicious honey. On the arrival of each bee, I can at once tell whether it has been a prior visitor or not, by its mode of procedure. Should it be a first visit, the little busy creature is for a time quite at a loss; it, of course, scents the honey, but cannot discover the entrance to the store-house. Convinced that there is plenty of the object of its search in the flower, the bee hurries over the surface in all directions, now running its head fast between the corolla and the outer double series of the rays of the nectary, now entangling itself amongst the beautiful rays themselves, and anon mounting the stipes, and ransacking the parts of fructification. At length, after a bustling scene, which frequently lasts for two or three minutes, and which the bee's certainty that honey is concealed somewhere in the neighbourhood prevents its quitting in despair, sometimes apparently by mere chance, at others by running the scent home, its indefatigable labours are rewarded. Now, with its tongue inserted amongst the rays

surrounding the shaft, and past the projecting rim which almost closes the entrance to the tube of the calyx, it drinks its fill, and flies off for the hive, to deposit its treasure, and profit by experience on a future trip. Far different is the manner of the bee that has been at the work before; it wastes not a moment of the time which the approach of winter renders doubly valuable, but at once alights on the flower, runs to its centre, and plunging its tongue into the liquid sweet, hurries back loaded to the hive."

Ancient writers speak of the practice of removing bees to fresh pastures every autumn, as common in their times; and this practice is still continued in many parts of the world with great advantage to bee-keepers. Towards the end of August, when wild flowers have almost disappeared, and gardens are fading, and clover is no longer in blossom, it is very desirable to find some fresh pasturage for the bees. The autumnal transportation of bees is approved of in the east, and also in many parts of the European continent; but in England it is seldom adopted. Neverthe-

less, it is almost universal in Scotland. "About five miles from Edinburgh," says Dr. Bevan, "at the foot of the Pentland hills stands Logan House, supposed the former residence of Sir W. Worthy, celebrated by Allan Ramsay, in his 'Gentle Shepherd.' The house is now occupied by a shepherd, who, during July and August, receives about a hundred bee-hives from his neighbours beyond the hills, that their bees may gather the honey from the luxuriant blossoms of the mountain heather." This is only one instance out of numbers, for in this way our careful northern neighbours manage to double their harvest of honey, taking not unfrequently almost the whole store from their hives before transporting them to the moors, and reaping an ample quantity again on their return in three weeks' time.

A writer on this subject regrets that our own moorlands are not made available to this end. "The very air," he says, "is often redolent with the rich perfume, while here and there a solitary bee is seen or heard, labouring with wearied wing among the inexhaustible stores of nature, and

scarcely able to regain its lonely shieling in the distant vale. When we consider the poverty of our mountaineers, and their frequent want of occupation, it is the more to be lamented that so easy a source of emolument should lie open to them in vain." From the Journal of Agriculture we learn that Poland is, perhaps, the greatest honey-producing country in Europe. In the provinces of Podolia, Ukraine and Volhynia in particular, the cultivation of the honey-bee has long formed an object of national importance; and these bee-gardens are not only very numerous and extensive, but they are also common in other parts of the kingdom. There are cottages in Poland, with very small portions of land attached to them, on which are to be seen as many as fifty hives; while there are farmers and landed proprietors who are in possession of from one hundred to ten thousand hives. There are some farmers who collect annually more than 200 barrels of fine honey, each barrel weighing from 400 to 500 lbs., exclusive of the wax. A tenant is often in this way enabled to pay his rent and taxes, to defray

other domestic expenses, and often to accumulate handsome dowries for his daughters.

The middle of September is about the time for the honey-harvest, or in-gathering of the stores of the hive. Those hives which are designed for winter stock must be set apart and weighed. A common straw hive when empty weighs from five to six pounds, an ordinary swarm about four pounds, the wax of a full hive two or three pounds, the farina in the cells one pound, making in all fifteen pounds. A stock, therefore, to be secure, must weigh double that amount, that is, it should not contain less than fifteen pounds of honey. The bees, it is true, may exist through the winter on a smaller quantity than this, but this would depend very much on the nature of the season; whereas with fifteen pounds they are considered safe, so far as food is concerned, whatever the temperature may be. These stock-hives being selected, the cultivator now proceeds to take the honey from the rest of the hives.

There are three ways of taking honey, known as "partial deprivation," "suffocation," and

"driving." For the first of these, hives of two stories are mostly employed. Immediately after the swarming season another story, or box, is added, either above or below, and one of those filled with honey is taken away. If this be done early enough in the season, there will be time for the bees to fill the empty story before winter; but if it be delayed, as is sometimes the case, until the beginning or middle of September, then the bees, having no opportunity of replacing what has been taken away, will be starved before the winter is over. This method of taking honey is by no means general, apparently because, from an error as to the *time* of performing the operation, it has frequently failed.

The second, or suffocating process, is effected by taking strips of linen rag, dipping them in melted brimstone, and placing them on a few sticks in a hollow place in the ground: then light is set to the rags, and the hive quickly set over them. Every hole being stopped up to prevent the escape of the sulphur fumes, the bees are soon suffocated, and the combs discoloured. This

cruel and objectionable practice is, perhaps, the most common of any, being the least troublesome, though not the most economical mode of getting at the honey.

The third, or driving system, saves the lives of the bees, by turning them out into a well-stored stock-hive, and need not give any great amount of additional trouble. It is thus described in the Naturalists' Library :—"In the evening, when all are quiet, turn up the hive which is to be operated upon, fixing it in a chair from which the stuffed bottom has been removed; place an empty hive above it, wrap a cloth round the point of junction, to prevent the bees from coming out and annoying the operator; then, with a short stick or stone in each hand, beat round the sides, but gently, for fear of loosening the combs. In five minutes the panic-struck insects will hastily mount into the empty hive, with a loud humming noise, expressive of their trepidation. The hives are then separated; that containing the bees is placed on its usual pedestal, and the other, containing the honey, is carried off. The union is next to be

effected. Turn up the stock-hive which is to receive the addition to its population,—with a bunch of feathers, or a small watering-pan, such as is used for watering flower-beds, drench them with a solution of ale and sugar, or water and sugar made a little warm. Do the same to the expelled bees; and then placing these last over the stock, mouth to mouth, a smart rap on the top of the hive will drive them down among the bees and combs of the undermost hive. Place this last on its pedestal, and the operation is completed. The strong flavour of the solution will prevent them from distinguishing between friend and stranger; and their first movement after recovering from their panic will be to lick the liquid from one another's bodies. It will be an advantage, though a little additional trouble, to search for and destroy the queen of the expelled bees before the union takes place."

When the bees have been removed from the hives by one of the above processes, the operation of extracting the honey must commence immediately, while the hive is yet warm. The warmth

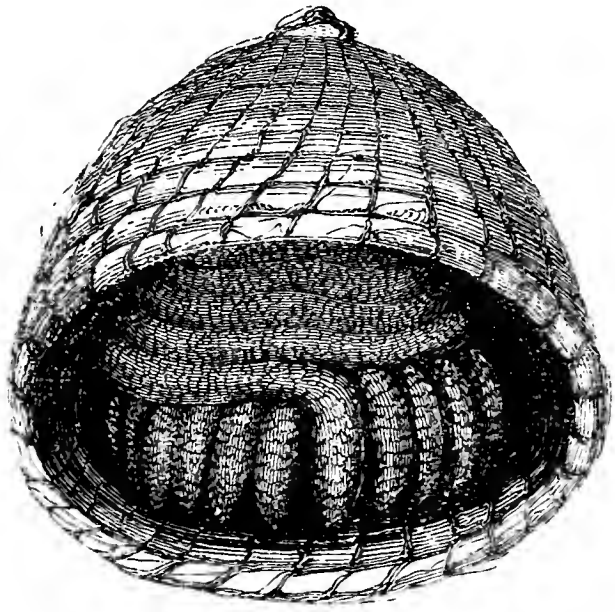
may also be kept up by allowing it to flow in a room where there is a fire. The comb should be kept from the air as much as possible, for which purpose some cultivators make use of a tin-covered vessel, pierced with holes at the bottom, and made to fit into another similar vessel fit to receive the honey. Pieces of comb, sliced horizontally, are put into this covered vessel, and the honey filters through the bottom, being first passed through a filter of wire-cloth or muslin placed at a little distance above the other. This upper filter prevents the vessel from becoming clogged with particles of wax, and increases the purity of the honey. A spigot in the lower vessel allows the honey to pass out into store jars.

Such are some of the processes by which the honey and wax of bees are made available to our use. Honey is of less importance to mankind since the discovery of sugar; but it will always rank among the wholesome and agreeable luxuries of life; while in countries where sugar is not so easily obtained as it is among ourselves, it holds a much more important position. In the Ukraine,

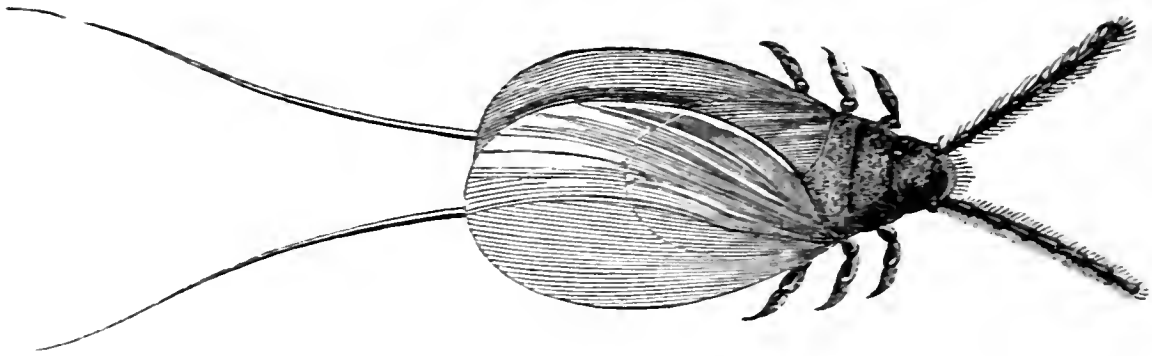
some of the peasants have four or five hundred bee-hives, and make more profit of their bees than of their corn. In Spain, also, the number of bee-hives is said to be immense, a single parish priest having been known to possess five thousand.

Rock-honey, found in some parts of America, is thin and clear as water, and is the produce of wild bees, which suspend thirty or forty waxen cells, resembling a bunch of grapes, to a rock.

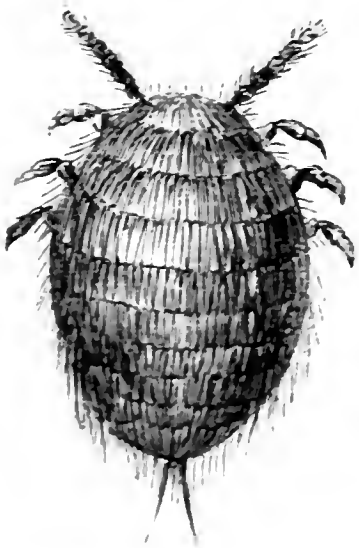
Green honey, found in the Isle of Bourbon, and exported to India, where it fetches a high price, is the produce of a bee much esteemed in that island. It produces sweet and fragrant honey, of the consistency of oil, and of a green colour.



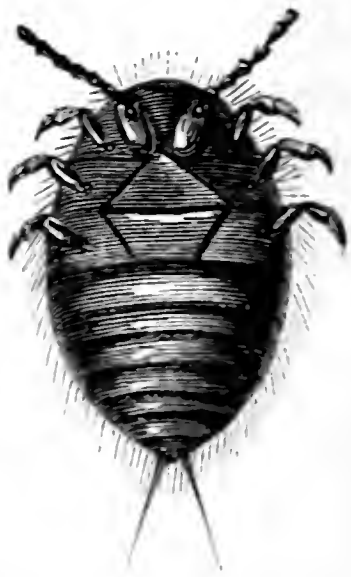
ANOTHER INTERIOR OF A BEE-HIVE.



MALE COCHINEAL INSECT.—(*Magnified.*)



FEMALE.—*Upper surface.*



FEMALE.—*Under surface.*

CHAPTER VI.

MANUFACTURE OF COCHINEAL BY THE COCCUS CACTI, OR COCHINEAL INSECT.

THE cochineal insect is extremely valuable in commerce, as yielding a brilliant red dye, and we may with propriety class it among insect manufactures, because, although its destruction is necessary to obtain the colouring matter, (the actual body of the insect forming the dye,) yet this beautiful colour is elaborated from the food on which it feeds, as honey and wax are elaborated by the bee, or silk by the silkworm. We do not find, it is true, any especial care or effort on the part of the insect in the production of the cochineal, and in this respect it differs from the examples already given; but the rich colour which pervades

the body of the insect appears to result simply from the juices of the particular species of cactus on which it feeds. Yet being to us the only means of obtaining the brilliant dye in question, the cochineal insects must be reckoned highly useful, though involuntary, manufacturers.

Cochineal insects are very small, delicate creatures, remarkable for the great difference in the form of the male and female. The former has a slender body, long antennæ, and two large wings; the latter an oval body, without wings, and short antennæ. The mouth in both insects consists of a small conical bill and sucker, adapted for feeding on the juices of vegetables. At first, all the young brood, whether male or female, resemble tiny red tortoises, and are busily engaged in feeding on the stems and leaves of plants, which they pierce with their sharp beaks so as to do much injury. During this active period of their lives the insects continue to increase in size, but the period soon arrives when they undergo a transformation. All the insects fix themselves firmly to plants or stems, and the male soon appears in his new dress as a fly, while the

female merely changes her skin, and remains fixed to the bark, which she gradually becomes so nearly like, that it is difficult to distinguish her. She now lays her eggs, which are very numerous, and which she accumulates beneath her body; but, at the same time, she gradually dwindles in size until her body becomes a mere pellicle or thin membrane inclosing the brood. The mother then dies, but her dried body remains as a sort of shell or cocoon for the protection of her young. When these are hatched, they soon make their way from beneath the scaly covering, and commence feeding vigorously on the juices of the plant.

To the persevering exertions of a French gentleman, M. Thierry de Menonville, it was owing that the culture of the cochineal became known in the West India islands. This gentleman left Port au Prince, in St. Domingo, in January 1777, with the express object of procuring some living cochineal insects of the finest sort from Mexico, and bringing them for propagation in the French West India islands; an enterprise for the expense of which the French government had allotted the

sum of four thousand livres. Owing to the jealousy of the Spanish government, there was great difficulty in penetrating as far as the cochineal districts, and M. Thierry pursued a plan to effect his object which cannot be considered justifiable, since it involved a departure from truth. At first he feigned ill health, and obtained permission to use the baths of the river Magdalena; but, instead of going thither, he proceeded as fast as possible in the direction of the desired district, where he was successful in getting some plants laden with cochineal, as a pretended remedy for gout. From his account of the expedition we gather the following particulars.

After numerous fatigues and dangers he at length saw himself near the end of his journey, and approached Guaxaca. At a village, within a short distance of that place, he saw, for the first time in his life, and with the utmost pleasure, the fine cochineal feeding on the nopal, or cactus, which it frequents. He saw a garden full of nopals, and not doubting but that they were laden with cochineal insects, he sprang from his horse,

and, under pretence of adjusting his stirrups, entered into conversation with the Indian proprietor of the garden. He asked him with apparent indifference what was the use of those plants, and was answered, that they were for the cultivation of *grana*. Feigning surprise, de Menonville asked to be permited to see this grana, and he was really astonished when the insect was brought to him, for he had supposed it red, and it was in fact covered with a white powder. "My doubts," he says, "were tormenting, but I suddenly thought of the expedient of crushing one upon white paper, when what did I see?—the true purple of kings!" Full of delight and anticipation, the traveller now set forward towards the spot where he might hope to make himself acquainted with the culture of the precious insect, and purchase a store for transportation.

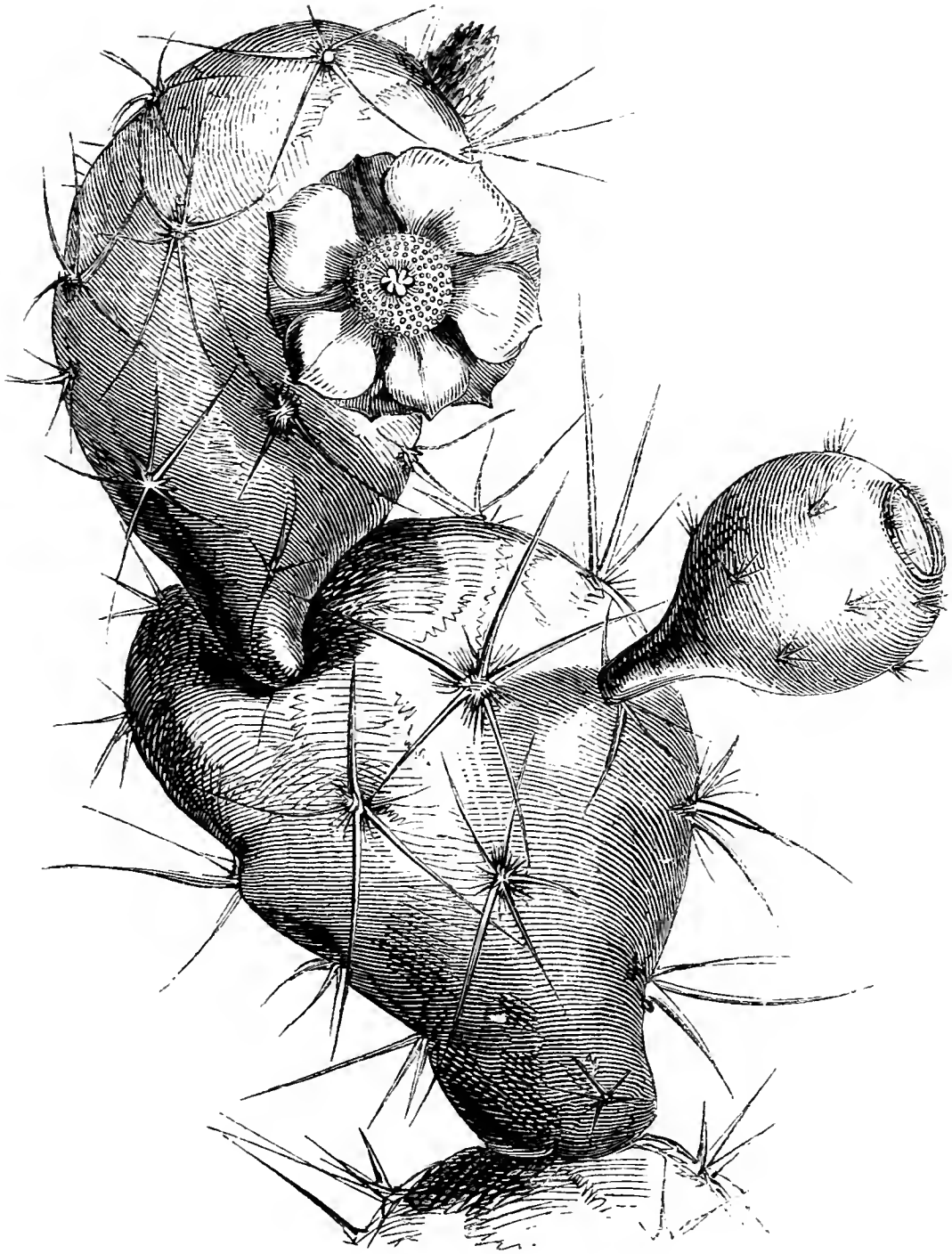
Nothing could be more beautiful than the situation of Guaxaca, capital of the province of that name. Standing in the midst of fertile and extensive plains, at the foot of a majestic mountain range, and watered by a fine and noble river, this

city is richly supplied with corn and fruits of all kinds, at the same time that its environs supply a most favourable site for the culture of the cochineal. The air, continually refreshed by easterly breezes in the morning, and westerly in the evening, is pure and delicious, like that of a May morning. Indeed, our traveller asserts, that for magnificence of site, beauty of decoration, excellence of soil, fine temperature, and abundance of European and American fruits succeeding each other without intermission, nothing is wanting to Guaxaca to make it an enchanting spot, but an active and industrious people, to avail themselves of its natural advantages.

At Guaxaca de Menonville acted with caution, and did not betray any undue anxiety respecting the cochineals. Yet he provided himself with chests large enough for their conveyance together with the plants on which they fed. Under pretence of buying flowers, he went into a garden where there was a beautiful nopalerie, and while they were making up the bouquet he had ordered, he took the opportunity of observing the arrangement of

the nopals. They were planted four feet apart in lines, the lines being six feet asunder. The nopalerie belonged to a negro, and it was here that a purchase might in all probability be effected. On another occasion, therefore, de Menonville took two Indian servants, each bearing a large hamper, and repaired very early in the morning to the garden. He left his servants at the entrance, and entered alone. The negro proprietor had scarcely risen, but he came forward in a frank and agreeable manner. De Menonville then told him, that being a physician, he was anxious to make an ointment of his own invention for the cure of gout, and for this purpose he wished to purchase some branches of nopals laden with cochineal, for which he was willing to pay whatever the owner should demand, provided he might make his own selection of the branches suitable to his purpose. The Indian willingly complied, and accordingly the hampers were brought in, and eight fine branches, each two feet high and so loaded with cochineals as to be quite white, were speedily cut, packed, and covered with cloths.

He then asked him how much he had to pay; the negro answered that he could not possibly sell them for less than two *reals*. Our traveller fully believed him, and would have purchased them, if necessary, at a much larger sum. That the negro might not think him dissatisfied with the bargain, he gave him a piaster (value eight reals), telling him he had no change, and therefore he should give him the rest to drink his health. The good old negro rubbed his eyes, thinking he was still dreaming, and then loaded de Menonville with thanks, while the latter brought in his two Indians, gave them the hampers to carry, and then set off as fast as possible. "My heart," he says, "beat quickly, for it seemed to me that I had carried off the golden fleece, but might yet be pursued by the furious dragon who kept guard over it. All along the road I kept saying, 'At last they are in my power;' and I could willingly have sung for joy if I had not been afraid of being heard. I arrived at my inn quite out of breath, without having met a single person in the streets; it was about sun-rise; no one was awake in the



COCHINEAL CACTUS.

house, and I crept quietly to my room, where I arranged my nopals, with inexpressible delight, in the caskets I had purchased for that purpose."

After innumerable difficulties and dangers this traveller reached St. Domingo in safety, but with only a small part of his insects living. These, however, he was successful in rearing and multiplying until a flourishing nopalerie was established. He found, by experience, that five or six species of *cactus opuntia* will nourish these insects, but that some are far more valuable than others. He also proved that the colours of the flowers and fruit of the plants, whether red, violet, yellow, or white, did not in any way affect the colour of the cochineal, nor indicate the greater or less aptitude of the plant to nourish the insect. The thorny species were less convenient on account of the pain and annoyance to the hands of those who managed the nursery; but in some of these the younger branches were nearly free from prickles.

The terms *nopalerie* for the nursery, and *nopal* for the plant, are preserved among the French cultivators of cochineal, in remembrance of the

Mexican origin of such nurseries. The enclosure should be secured by walls or a quick hedge; not from the fear that any animal will prey upon the plants, since no large quadruped is known to have a taste for them; but simply to keep out such as might by accident or fear be driven through the grounds, and trample on and destroy the crop.

An acre, or an acre and a half of land, when planted with nopals, is sufficient to keep one Indian well employed during six months of the year. The plants should be so situated as to receive the full influence of the morning sun, which is of great consequence to the welfare of the cochineal. Every part of the ground should be as neat as a well-kept garden, and every injurious insect watched for and destroyed. The spider alone is permitted to weave her nets in peace, and for this reason: she is the great enemy of many insects which injuriously affect the cochineals, while she herself does not touch one of them. The nopal requires a good soil, where the drainage is excellent. Shelter from the wind, and exposure to the sun, are the two great requisites, and with

this there must be a tolerably settled climate, otherwise the harvest will be uncertain.

When in a favourable situation, the nopal requires less care and cultivation than almost any other plant: it would even appear that the less it is meddled with the better it succeeds. As soon as a nursery ground is laid out, cleaned, and drained, planting commences, the season being the dry period just before the spring rains. Alleys or paths are marked out, forming squares: parallel lines are drawn across these squares north and south. Here the nopals are planted at two feet distance from each other, being clean cuttings from the old plant, and not torn or broken from it. The Indians of Guaxaca plant two or three cuttings in each hole, lest any accident should prevent one from striking. Eighteen months afterwards the plants will be in a state to nourish the cochineal.

The sowing of cochineal, as it is called, is performed at day-break, the insects being conveyed from the old plants and attached to the new. For this purpose they are placed in little nests made

by the natives, and attached with thorns to the leaves of the nopal. Here they quickly multiply to an astonishing extent. A nopalerie is in perfection six years, after which the insects are taken away and the plants cut down.

The cochineal harvest takes place every year as soon as the young insects begin to run about. Assembling his friends, old and young, the owner of the cochineal ground enters it at break of day with a crowd of men, women, and children, provided with knives six inches long and two wide, and also with dishes and with baskets. The blade of the knife is rounded at the top, so as to injure neither the insect nor the plant; this is passed gently between the skin of the nopal and the clusters of cochineals with which it is covered, causing the latter to fall into the dish or basket, which the left hand holds ready to receive them. A child of ten years old may thus gather ten pounds of insects in a day, which being killed and dried will yield about three pounds and a half of cochineal. The best method of killing the insects is by pouring boiling water on them, and allowing

it to remain one, two, or three minutes. The water is preserved, as it necessarily has some of the colouring matter of the insects; the latter are spread out to dry in the sun and wind, being turned occasionally by hand. Ten persons, it is said, can thus prepare two hundred pounds of cochineal in two days. Such is the history given by de Menonville himself, in his volumes entitled '*Voyage à Guaxaca.*' Baron Humboldt, describing the management of cochineals in this and in other parts of South America, gives some additional particulars. He ascertained that in a colder climate, the colour of the cochineal is equally fine, but the harvests are more uncertain. Plains or valleys are generally more favourable to the rapid increase of the cochineals than elevated ground, but such places also abound in insect enemies, and in lizards, rats, and birds, which devour the crop. Great care is required in clearing all the joints of the nopals: for this purpose Indian women use a squirrel's or a stag's tail, and will sit for hours crouched near a single plant. Notwithstanding the high price of cochineal, it is very doubtful

whether the trade would answer in any country where labour is more valuable. In some parts of Guaxaca (called by Humboldt Oaxaca), they obtain three harvests of cochineal in the year, the first being the least lucrative, because the bodies of the insects yield very little colouring matter when they die naturally, and this is the case at the first harvest, when they have just brought forth their young. Many of the negro proprietors of nopaleries, especially those in the neighbourhood of Oaxaca, have a very ancient and singular custom of making their cochineals emigrate during the rainy season. As the Spaniard causes his flocks of merinos to emigrate on the approach of cold, so do these negroes send away their crop during a season which might prove fatal to them. The insects are packed in hampers, and carried as quickly as possible, on the backs of negroes, to a place nine leagues distant from the town, not so heavily visited with rain. Here they distribute them on the nopals, and keep them there till the month of October, when they return with their freight, and replace it in the nopaleries of Oaxaca.

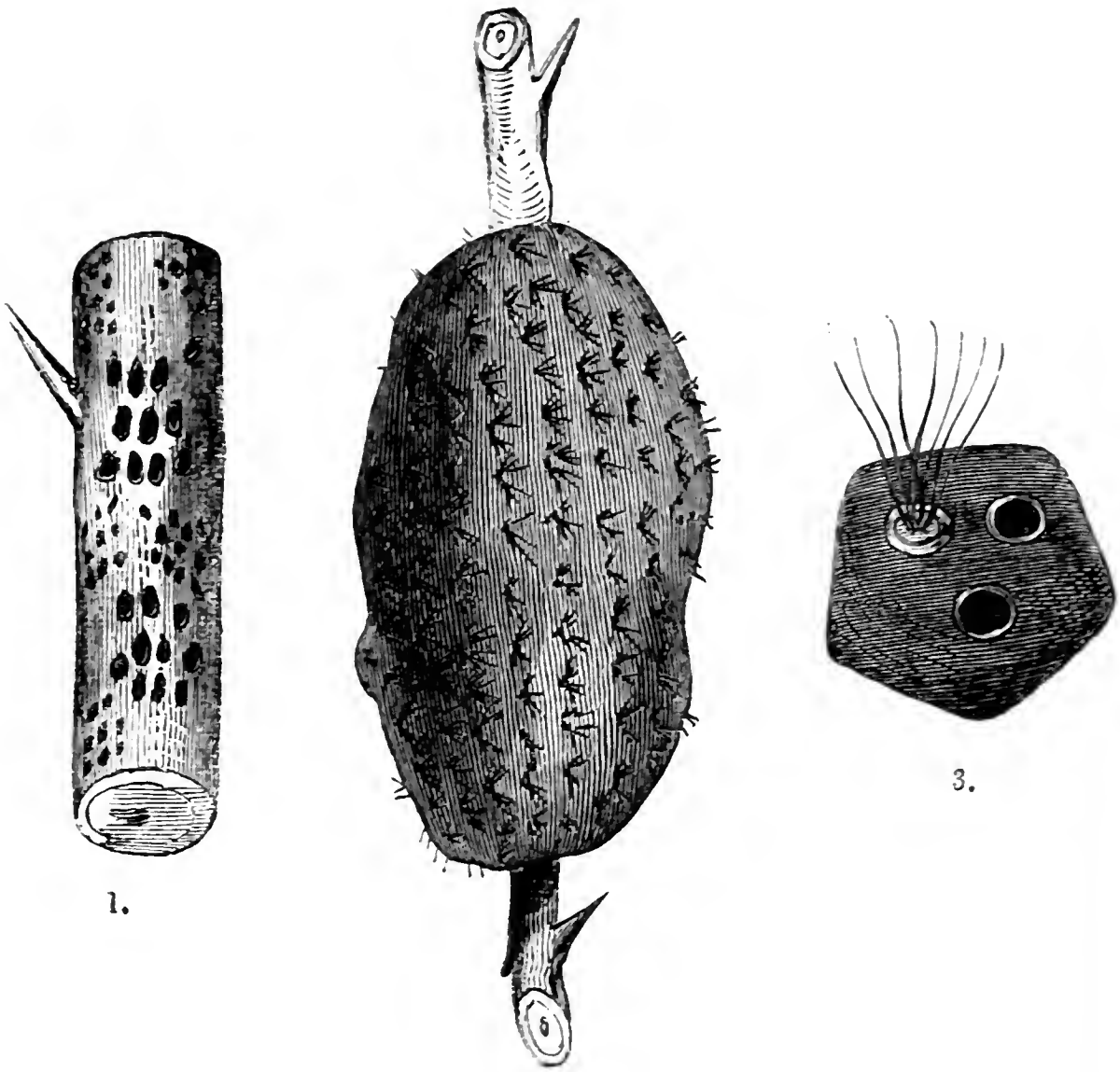
The plantations of cochineal cultivated by M. Thierry, at St. Domingo, were so successful that in 1789 there were more than four thousand plants in a single nopalerie, and the produce was ascertained by chemists to be quite equal to that of Mexico; but at the time of the French Revolution, the political troubles of St. Domingo caused the destruction of the plantations. Cochineal has been cultivated with some success in several of the British West India islands. Thus the Rev. L. Guilding, writing a few years ago to Dr. Hooker, says, "I possess a considerable nursery of this cactus, inhabited by thousands of the true *Coccus cacti*, and I do not despair of being able to send to the Society of Arts a large quantity of dried insects before the termination of the present year."

So important was the acquisition of this insect to the East India Company, that they offered a reward of six thousand pounds to any one who should introduce it into India, where hitherto the Company had only succeeded in procuring from Brazil the wild kind producing the *sylvestre* cochi-

neal, which is of inferior value. The true cochineal insect, and the cactus on which it feeds, are said to have been of late years successfully introduced into Spain and the French colony of Algiers, and now exist in the stores of the *Jardin des Plantes* at Paris, and also in those of King Leopold at Claremont.

Stephens, in his Travels in Central America, does not omit to notice the cultivation of this insect, which was carried on extensively in the neighbourhood of the ruined city of La Antigua Guatimala. "Emerging from the city," he says, "we entered the open plain, shut in by mountains, and cultivated to their base with cochineal. At about a mile's distance we turned into the hacienda of Señor Vidaury. In the yard were four oxen grinding sugar-cane, and behind was his nopal or cochineal plantation, one of the largest in the Antigua. The plant is a species of cactus, set out in rows like Indian corn, and, at the time I speak of, it was about four feet high. On every leaf was pinned with a thorn a piece of cane, in the hollow of which were thirty or forty insects. These

insects cannot move, but breed, and the young crawl out and fasten upon the leaf. When they have once fixed, they never move; a light film gathers over them, and as they feed, the leaves become mildewed and white. At the end of the dry season some of the leaves are cut off and hung up in a storehouse for seed, the insects are brushed off from the rest and dried, and are then sent to minister to the luxuries and elegancies of civilized life, and enliven with their bright colours the *salons* of London, Paris, and St. Louis in Missouri. The crop is valuable, but uncertain, as an early rain may destroy it, and sometimes all the workmen are taken away for soldiers at the moment when they are most needed for its culture. The situation was ravishingly beautiful, at the base and under the shade of the Volcano de Agua, and the view was bounded on all sides by mountains of perpetual green; the morning air was soft and balmy, but pure and refreshing. With good government and good laws, and one's friends around, I never saw a more beautiful spot on which man could desire to pass his allotted time on earth."



1. 2. 3.

4. 5. 6.

1. BRANCH COVERED WITH LAC. 2. SMALL TWIG LADEN WITH LAC. 3. PORTION OF LAC (*magnified*). 4, 5, 6. LAC INSECT IN ITS SEVERAL FORMS.

CHAPTER VII.

MANUFACTURE OF GUM LAC BY THE LAC INSECT.

ANOTHER insect of the same family as the cochineal, prepares a substance called gum lac, which is used as a dye, and also as a varnish. This is the lac insect, *(coccus lacca,)* found on several kinds of trees in the East Indies, especially in the uncultivated mountains on both sides the Ganges, where it is produced in such abundance, that were the consumption ten times greater than it is, the markets might be readily supplied. So great is the accumulation of these insects on the trees which they frequent, that the branches appear as if covered with red dust, and their sap is so much exhausted, that they wither and produce no fruit: the leaves also drop off, or turn to a blackish hue.

The insects fix themselves so close together, that it is supposed that not more than one in six can have room to complete her cell. It is said they are transplanted from place to place by birds, which cannot perch upon the branches without carrying off a number to the next place they rest upon.

The female, when about to lay her eggs, becomes completely glued to the branch by a semi-pellucid liquid, which accumulates round the body, and hardens by exposure to the air. This is the gum lac, the original use of which is to form a cell for the young. When the eggs are laid, the parent insect becomes a mere lifeless bag of an oval shape, containing a small quantity of beautiful red liquid. On this liquid the young insects feed as soon as they come to life; after which they pierce the cell, and come forth one by one. Some small branches of *mimosa cinerea*, gathered when the lac was in a very fresh looking state, became covered with myriads of exceedingly minute animals at the end of fourteen days. They issued from small holes over the surface of the cells, and when single ran about pretty briskly ; but in general they were

so numerous as to be crowded over one another. The cells themselves were very much like amber; the outer portion was strong and resisting, but the partitions of the interior were thinner, and formed irregular squares, pentagons, and hexagons, having no communication with each other.

There are four sorts of lac known in commerce, but these are only so many different preparations of the same substance. Stick lac is the lac in its natural state, with much of the woody parts of the branches adhering to it: this is collected in the East twice a year, the only trouble being to break off the twigs and branches, and take them to the nearest market, with the lac upon them; or, if destined for exportation, the lac is separated from the larger branches for convenience of freight.

Seed lac is the second description known in commerce. This is a collection of granules, obtained from the former after the colouring matter has been extracted by water, but this is seldom imported, being manufactured into shell lac in India. Lump lac is the third form, being merely the granules further purified and made into lumps.

Lastly, there is shell lac, in which the substance is purified to the utmost by being put in bags and held over a fire until sufficiently melted to pass through the pores of the linen. The bags are then pressed and squeezed at the same time that they are passed over a smooth surface of wood, thus depositing the lac in thin layers. The fineness and purity of the lac will of course depend on the fineness of the bag through which it is passed. Shell lac if pure will take fire when laid on a hot iron, and will burn with a strong but not disagreeable smell. The heat of the ship's hold is very apt to run this commodity into a solid mass, in which case its value is much depreciated.

The different kinds of lac are largely used by Indians for ornamental purposes. Of the lump lac they make *bangles*, or armlets for women of the lower class; shell lac being employed for the same kind of ornaments for the upper classes, and also for beads, chains, necklaces, and other adornments. They also make a good varnish by melting the lac, colouring it with cinnabar or some other pigment, and making it into sticks like

our sealing wax. The box, cabinet, or other article about to be varnished, is made hot by a charcoal fire, and then rubbed over with a stick of lac, the surface being afterwards smoothed with a piece of folded plantain leaf to make it equal. A similar varnish is often used on images and ornamental figures. The religious houses of the Indians are often adorned with very thin beaten lead, coloured with various varnishes made from lac. The leaf of lead is laid upon a smooth heated iron while the varnish is being applied.

Lac is also extensively used as a dye. By pouring warm water on stick lac, a crimson solution is obtained, which is the source of much of the value attached to lac. This colouring matter is extracted in various ways, and made into small square cakes for sale; these go by the names of lac dye, lac lake, or cake lake. When broken, the cakes are dark coloured, shining, smooth and compact, and when scraped or powdered they present a bright red colour approaching carmine. The native mode of dyeing with this substance is described as follows. They take one gallon of the

red liquid, and add to it three ounces of alum. Three or four ounces of tamarinds are boiled in a gallon of water and strained. Equal parts of the red liquid and of the tamarind water are then mixed over a brisk fire; and the pieces of silk or cotton cloth to be dyed are dipped and wrung alternately, until they have received a proper proportion of the dye. To deepen the colour they increase the proportion of the red liquid, and lengthen the time during which the cloth remains immersed in it. The colour is rendered permanent by the use of bark in the rinsing water.

There is yet another and a singular employment of lac among the Indians. The polishing grindstones used by eastern lapidaries are composed of a mixture of three parts river sand with one part lac: these are mixed in a vessel over the fire, and then formed into the shape of a grindstone; the part of the lac being merely that of a cement to hold the sand together.

In this country lac is valuable partly as a dye, partly as a varnish. As a dye it is less beautiful, but more durable than cochineal. It forms the

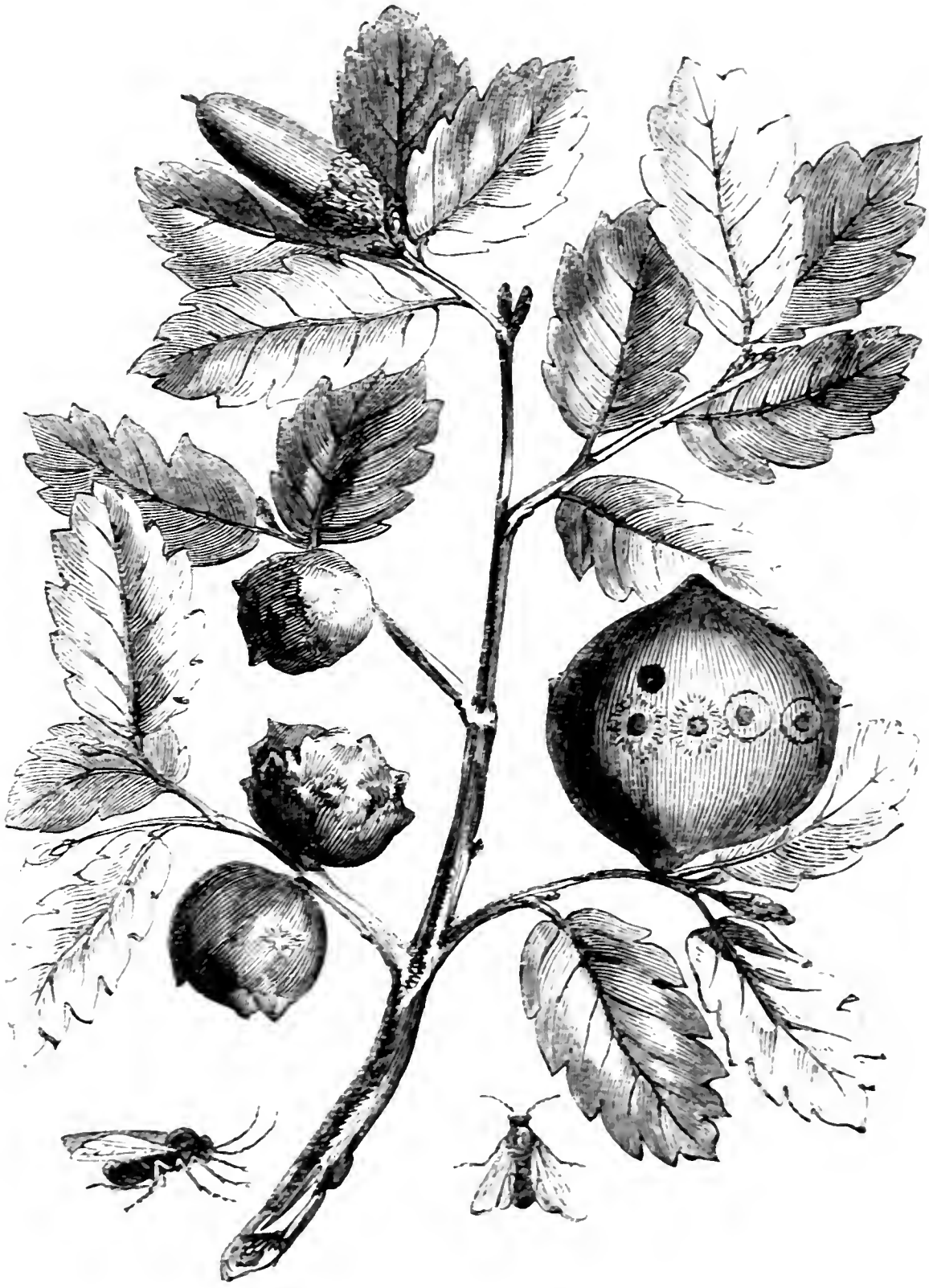
best kinds of sealing wax, and is also used in the hat manufacture.

With regard to its use as a dyeing drug we find the following remarks in the Entomology of Kirby and Spence. "It has been employed to impart a blood red or crimson dye to cloth from the earliest ages, and was known to the Phœnicians before the time of Moses, under the name of *Tola* or *Thola*, to the Greeks under that of *Coccus*, and to the Arabians and Persians under that of *Kermes* or *Alkermes*; whence, as Beckmann has shown, and from the epithet *vermiculatum* given to it in the middle ages, when it was ascertained to be the produce of a worm, have sprung up the Latin *coccineus*, the French *cramoisi* and *vermeil*, and our *crimson* and *vermilion*. It was most probably with this substance that the curtains of the tabernacle (Exodus xxvi.) were dyed deep red, (which the word scarlet, as our translators have rendered it, then implied, not the colour now so called, which was not known in James the First's reign, when the Bible was translated;)—it was with this that the Grecians and Romans produced their crimson;

and from the same source were derived the imperishable reds of the Brussels and Flemish schools. In short, previous to the discovery of cochineal, this was the material universally used for dyeing the most brilliant red then known; and though that production of the New World has, in some respects undeservedly, supplanted it in Europe, where it is little attended to except by the peasantry of the provinces in which it is found, it still continues to be employed in great part of India and Persia.

Some other insects besides the cochineal and lac insects are found to produce dyes. The galls of a peculiar species of aphis are used in the Levant, Persia and China, for dyeing silk crimson, and it is thought that the galls of another species of this insect, common on the fir trees of this country, might be employed for a similar purpose. A species of mite is employed in Guinea and Surinam as a dye, and it is suggested that the beautiful little dazzling red mite which is common here, might also yield a valuable tincture. Réaumur has even suggested that water colours of beautiful tints not

otherwise easily attainable, might be procured by feeding the common clothes-moth on different coloured wools. The excrement of this insect always retains the colour of the substance forming the food, and mixes well with water to form a pigment.



NUT GALLS AND THE GALL INSECT.

CHAPTER VIII.

MANUFACTURE OF NUT GALLS BY THE GALL INSECT.

"No present that insects have made to the arts is equal in utility and universal interest, comes more home to our best affections, or is the instrument of producing more valuable fruits of human wisdom and genius, than the gall-insect: I mean the fly that gives birth to the gall-nut, from which ink is made. How infinitely are we indebted to this little creature, which at once enables us to converse with our absent friends and connexions, be their distance from us ever so great, and supplies the means by which, to use the poet's language, we can

"——— give to airy nothing
A local habitation, and a name!"

enabling the poet, the philosopher, and the divine, to embody their thoughts for the amusement, instruction, direction, and reformation of mankind."*

The oak which furnishes this gall is common throughout Asia Minor, from the Bosphorus to Syria, and from the shores of the Archipelago to Persia. It is more frequently seen under the form of a shrub than a tree, rarely attaining six feet in height. Its leaves are smooth, toothed at the edges, of a clear green on both sides, and having a very short leaf-stalk; they fall every year, at the end of autumn. The acorn is two or three times longer than its cup, the latter is sessile, slightly downy, and furnished with small scales. The gall is hard, woody, and heavy, growing out of the buds of young branches, and acquiring a diameter of from four lines to an inch. It is generally round, and covered with knots, some of which are pointed.

This gall-nut is much more valuable if gathered before it is ripe, that is to say, before the insect

* Kirby and Spence.

which produced it has made its escape. In this state it has a bluish appearance, and is unperforated; whereas those from which the insect has departed are lighter in colour and in weight, and are less useful in dyeing.

The Orientals are very careful to gather in this crop at the exact time which experience has proved to be the best, namely, that in which the excrescence has attained its greatest size and weight. If there is any delay, the insect undergoes its metamorphosis, pierces the shell, and appears under its form of a winged insect. From this time the gall-nut no longer derives from the tree those juices which were necessary for the nourishment of the insect, but dries up, and loses the greater part of those qualities which make it valuable in commerce. The Aga of the district takes care that the cultivators traverse frequently, at the time of the harvest, the hills and mountains which are covered with this oak. He has an interest in obtaining galls of good quality, because he levies a tax on the produce. The first gatherings are set aside; they are known in the East

under the name of *yerli*, and are called in commerce *black galls*, and *green galls*. Those which have escaped the first search, and which are gathered a little later, are named *white galls*, and are of a very inferior quality.

The galls from Mossoul and Tocat, and in general those which come from the eastern part of Turkey, are less valued than those from the neighbourhood of Aleppo, of Smyrna, Magnesia, Diarbekir, and all the interior of Natolia.

The acorns of this oak are nearly always neglected; being left as pasturage for goats and wild boars: this it is thought contributes much to render the oak small and stunted, because in devouring the fruit, these animals also consume a part of its foliage and young branches.

The body of the insect which produces the gall-nut, is of a fawn colour, with obscure antennæ; the abdomen is shining brown. It is sometimes found in its perfect form in the interior of the nut.

On the same oak are frequently found a great number of other galls, which are not gathered,

because they are of no use in dyeing. One of these is represented in the frontispiece to this chapter, and is remarkable for its large size. It is spongy, very light, of a reddish brown colour, and covered with a resinous matter. It is also furnished with a circular range of tubercles, placed near its greatest circumference. This is produced by a different insect, called by Olivier *Diplolepis gallæ resinosæ*; a figure of which is also given on the right hand side.

Gall-flies of various kinds attack our oak trees in this country, and also our willows, hawthorns, roses, &c. A few words respecting the excrescences they produce, may therefore assist our ideas of the proceedings of the valuable insect described above. Very few persons are unacquainted with oak-apples, or small roundish, flattened bodies growing on the leaves of the oak. These are sometimes tinged with brown, or pink, or pale yellow, so as to appear not much unlike very small apples, attached to the leaf. Each of these curious bodies is formed by a small fly of the same nature as that which forms the gall-nut. This

insect alights on the leaf, pierces it with a very sharp instrument with which she is provided for this purpose, and deposits an egg so minute as to be almost invisible to the human eye. The puncture of this insect produces a diseased action in

LEAF GALLS.

the leaf, so that the parts immediately surrounding the egg swell and harden until the apple-shaped body is produced. This is now an admirable place of shelter, and a reservoir of food for the insect within, which remains snugly encased until it arrives at its perfect state, when it cuts its way out through the solid substance of the gall.

This is only one out of many forms of gall that may be found on the oak, where sometimes the leaf is attached, sometimes the catkin, and sometimes the young bud. Another form of that on

OAK SPANGLE.

the leaf consists of very small circular discs fixed to the under part by their central points. The outer side of the disc is red and hairy, the inner side smooth. Each disc contains a single insect, which remains in it long after the leaves have

fallen to the ground. The common name of this curious excrescence is "oak-spangle."

Still more singular is the gall found in the catkins of the oak. The flies deposit their eggs in the stalk of the stamen-bearing flowers, which in consequence become adorned with what appear to

CURRANT GALLS.

be straggling bunches of currants or bird-cherries. Placed at short distances from each other on the thread-like stem, these excrescences so much re-

semble currants in size, shape, and mode of growth, that they have been named "currant galls."

Among the species of gall to which our oaks are subject, there are some which grow at the end of the twig, as for instance, that called the artichoke-

ARTICHOKE GALL.

gall, which comes the nearest in appearance to the nut-gall of commerce, since it is, in common with that nut, an irregular development, not of the leaf or flower, but of the bud. The artichoke-gall

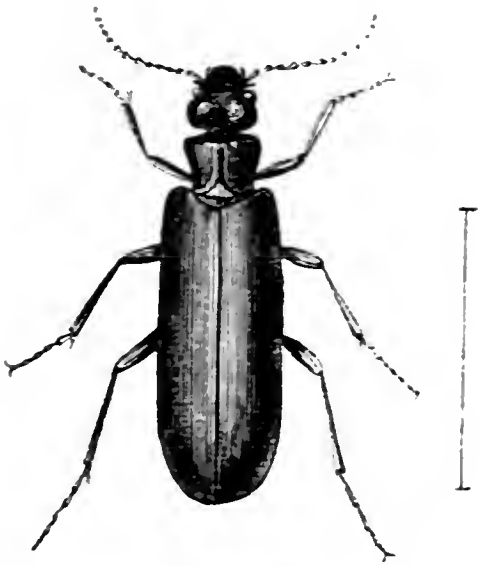
might indeed be easily mistaken for the fruit of the tree, by any one unacquainted with the habit of the oak. It is a cone-like body, consisting of a number of leafy scales overlapping each other, but on being dissected it is found, like other galls, to contain insects in various stages of their growth, according to the season. In the same way, the nut-gall, being a disease of the bud, or extremity of the young shoots of the oak on which it grows, has the appearance common to some other kinds of fruit, and would seem to be the ordinary produce of the stalk, did we not find that acorns also grow on the same tree. The hard and brittle texture of the gall-nut also, so different from the substance of our own oak-galls, would be still more likely to deceive, and indeed has deceived a highly respectable writer, who declares from his observation of the dried galls of commerce, that the nut is the fruit of a tree, and not a mere excrescence.*

How it is that the different species of gall-fly

* Aikin.

should produce such varied results, and why one excrescence should be the oak-apple, another the spangle, a third the artichoke, and a fourth the nut, is indeed a mystery. But that these small insects do really produce the excrescences in question, is an ascertained fact, and a most important one in the commercial world.

Nut galls contain a large quantity of the vegetable principle called *tannin*, being the astringent property for which oak-bark is in so much repute. They also abound in an acid called from thence *gallic acid*, which is the important ingredient in black dyes, and in fixing and improving several other colours, as well as in the composition of ink.



BLISTERING BEETLE.

CHAPTER IX.

OTHER INSECT PRODUCTIONS USEFUL TO MAN.

Almost any article could be better spared from the materia medica, than an insect remedy called *cantharides*, or Spanish flies. This consists of the bodies of small beetles, in which resides an active blistering principle of great importance, not only as an external application, but also sometimes as an internal remedy. The insect chiefly used in

Europe is the *cantharis vesicatoria*, for the most part rare in England, but seen on some occasions in great numbers, as in the summer of 1837 in Essex, Suffolk, and the Isle of Wight. Other insects of the same family are employed in foreign countries.

The true blistering beetle has complete wings and wing cases; its body is long and narrow, varying in size, but in general about nine lines long and two or three lines wide. It is of a rich green and golden colour, very shining and delicately punctured, with the antennæ black, except the first joint.

"The cantharis is one of those insects which have been most anciently and most universally known. Physicians, who were the first natural philosophers, and the first observers of nature, have made mention of the cantharides in the remotest times. But they have only considered them under that relation which was most suitable to their own profession, and as furnishing to medicine one of its most powerful agents. The naturalist, who is less anxious about becoming acquainted with the medicinal virtues of the dead,

than with the peculiar habits of the living cantharides, is yet very far from having acquired in this respect extensive and satisfactory information. The only species which has been deemed to be endowed with useful properties, has caused a forgetfulness of all the others which compose the entire genus; and all that we know in general respecting these insects, is that in our European climates they live on plants, devour the leaves of certain trees, shun the cold, appear at the commencement of spring, and disappear at the beginning of autumn. * * * It is more than probable that experiments on insects relatively to their utility in medicine and the arts, have been too much neglected in general. Their diminutive size has doubtless caused them to be too much despised. It cannot however be doubted, that there must be a great number of them whose virtues are at least equal to those of the cantharides, and many others which are less acrid and less caustic might in many cases be taken internally, with less danger and a greater chance of success."

The early history of this insect is not well known. The female buries her eggs in the ground; the larvæ have a soft body of a yellowish white colour; they live in the earth, and feed on various roots. When full grown they change into the nymph state in the earth, and do not emerge from it until they have assumed the perfect insect form.

They are very abundant in Spain and in the South of France, especially in June, when they assemble in swarms. This is the time for gathering them, and the hour of sunset or sunrise is chosen for the purpose, as they are then in a somewhat torpid state. They are found upon ash-trees, honey-suckles, lilacs, rose-trees, poplars, elms, &c., the leaves of which they devour, and when this food fails they attack corn and grass, and do much damage. The swarms are preceded by a fœtid odour resembling that of *mice*. They are gathered in various ways; the most simple is to spread cloths under the tree upon which a swarm has settled, and then to shake them down; they are afterwards collected upon a hair sieve, and held

over the vapour of boiling vinegar, which kills them; or the cloth in which they are collected may be folded loosely up and dipped in vinegar, which has the same effect. Another method is to boil a quantity of vinegar under the tree where they are collected, and the ascending vapour kills them.

The particles emitted by these insects are so very corrosive that persons are liable to be violently affected who attempt to gather them with bare hands during the heat of the day. It is also dangerous to be under a tree where a swarm has gathered. Persons who collect them should always wear a mask and gloves.

After the insects are killed they must be dried; this is done in the sun or in a heated room, upon tiles covered with cloth or paper. They are moved about from time to time with a stick, or with the hands furnished with gloves. When properly dry they are so light that fifty weigh scarcely a drachm.

They are packed in boxes or barrels lined with paper and perfectly dry. If damp gets to them they contract a detestable odour, and are unfit for use.

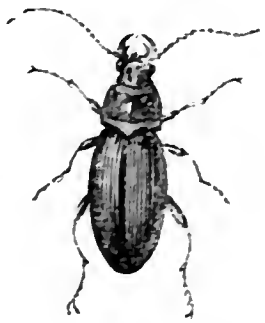
A portion of our supply of cantharides is from

Astracan and Sicily: but the greatest quantity is from St. Petersburgh, the Russian insects being superior to those of Sicily and France.

In using cantharides they are reduced to powder, mixed with some fatty substance, and applied in the form of a plaster to the surface of the body: it begins to act immediately, and separates the outer skin from the dermis with great rapidity.

A singular employment of insects in the composition of *soap* is made in some parts of Africa. Geoffrey the younger relates, that being at the village of Postudal, some leagues from Senegal, in search of insects, one of the negroes whom he had employed in the same pursuit brought him a vessel containing an immense quantity of a small species of carabus, and informed him that this insect entered into the composition of the soap used in that country; at the same time he exhibited a ball of a dark-coloured soap, the properties of which are similar to the soap used in Europe. It appears that the insect abounds in alkali, which makes it useful for the purpose in question.

The following figure of the soap insect (*Carabus saponarius*), is copied from M. Olivier's large work on insects.



Another useful insect substance is a kind of resin, or more properly speaking, wax, which by adulteration with a resinous substance is made heavier for the market. This is found in the province of Coquimbo, South America, and is the production of a caterpillar, which feeds on a shrub called *chilca*, a species of origanum. The caterpillars are of a red colour, and about half an inch in length. They appear in great numbers in the beginning of the spring on the branches of the chilca, where they form their cells of a kind of soft wax. In these they become changed into a small yellowish moth, with black stripes upon the wings. The wax is at first very white, by degrees becomes

yellow, and finally brown; this change, and the bitter taste which it acquires, is supposed to be owing to the fogs which are very frequent in the provinces where it is found. It is collected in autumn by the inhabitants, who boil it in water, and afterwards make it up into little cakes, in which form it is brought to market. In order to increase its weight, many are accustomed to mix it with the resin obtained from another resinous shrub, and in this state great quantities are sold to ship-masters, who use it for paying their vessels.

Upon the branches of the wild rosemary is also found a whitish viscous substance, in globules of the size of a hazel-nut, containing a very limpid oil, which proceeds from the shrub. These glands serve for the habitation of a kind of caterpillar, which becomes transformed into a small fly, with four brown wings, of the genus *Cynips*.

The foregoing details will be sufficient to show that we are indebted in no small degree to the

labours of insects for comfort, convenience, and health. It becomes us then to receive not unthankfully the benefits they confer, while we view them as the agents of a higher power, under whose direction they work with ceaseless activity in their humble sphere, and produce results, not less astonishing in themselves, than valuable and beneficial to mankind.

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